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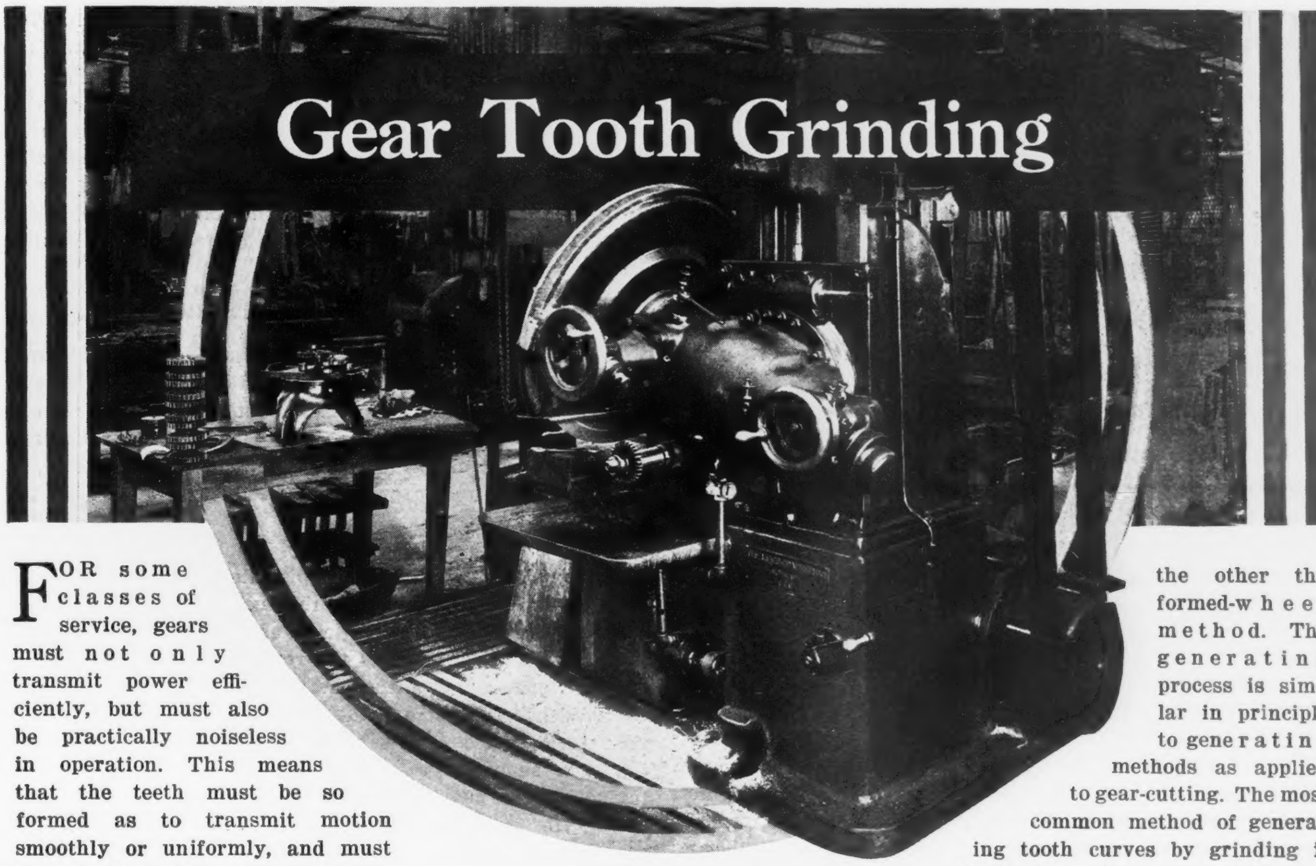
Gear Tooth Grinding



Principles of Different Gear Tooth Grinding Processes—Types of Gear Tooth Grinders, and their Application

By FRANKLIN D. JONES

FOR some classes of service, gears must not only transmit power efficiently, but must also be practically noiseless in operation. This means that the teeth must be so formed as to transmit motion smoothly or uniformly, and must have hard working surfaces to prevent wear which later would cause noise. This applies particularly in the automotive industry, especially in producing transmissions for cars of the better grades. In this industry, large sums have been expended in attempting to manufacture quiet-running gears, because transmissions that are reasonably silent as well as durable and efficient are a commercial necessity. Losses in this industry which are directly traceable to noisy gearing have been very large; for notwithstanding the accuracy attainable by modern gear-cutting processes, some distortion is bound to occur in connection with the hardening process which is required to obtain the degree of durability and strength, combined with lightness, demanded by modern conditions. On account of this distortion, gears have been scrapped by the thousands, and a vast amount of time has been lost in taking down transmissions which under tests proved to be too noisy.

To avoid this waste without sacrificing the desirable qualities of hardened gears, machines for grinding gear teeth have been developed, and while these ground gears are largely used in the automotive field at present, the indications are that hardened and ground gearing will be utilized on a greatly increasing scale in various branches of the machine-building industry. This general review of gear tooth grinding will deal with the fundamental principles of different processes and with the application of various types of gear grinding machines. In connection with the grinding of gears it is, of course, essential to utilize a method of testing the accuracy of tooth profiles and tooth spacing that is in keeping with the refinements attainable by the grinding process, but developments along this line will not be included owing to the lack of available space.

Methods of grinding gear teeth may be divided into two general classes, one being the generating method and the other the formed-wheel method. The generating process is similar in principle to generating methods as applied to gear-cutting. The most common method of generating tooth curves by grinding is illustrated diagrammatically in Fig. 1. The grinding is done by the flat face *A* of the wheel, which is perpendicular to the wheel axis and inclined from the vertical an amount equal to the pressure angle of the gear to be ground. Therefore this flat side of the wheel face represents the side of a rack tooth, the same as the teeth of certain gear-cutters, like the hob for example.

Now, in order to generate involute tooth curves, provision must be made for rolling the gear past the revolving grinding wheel, just as though an accurate gear were rolling along an accurate rack having the side of one tooth in the same position as the grinding face of the wheel. A common method of obtaining this rolling or generating motion is by the use of steel tapes in conjunction with a drum or disk having a radius approximately equal to the pitch radius of the gear. This mechanism will be explained in greater detail later in the section of the article dealing with the mechanical features of a generating type of gear-grinding machine.

The grinding wheel used in connection with the method represented by Fig. 1 is quite large in diameter, and does not have to be traversed parallel to the axis of the gear being ground. In other words, the wheel rotates about a fixed axis, but it covers the entire working surface of a tooth as the gear rolls past the grinding face. A slight arc or curved shoulder is formed at the bottom of the ground surface, but this does not interfere with the tooth action, provided it is confined to the clearance space and cannot come into contact wth the ends of meshing teeth. On this type of machine, the diamond for truing the flat grinding face is so mounted that it swings in a plane perpendicular to the axis of the wheel-spindle. The wheel face is maintained in one position, because, in dressing it, the wheel is adjusted toward the truing diamond instead of the diamond being adjusted toward the wheel. This method is commonly

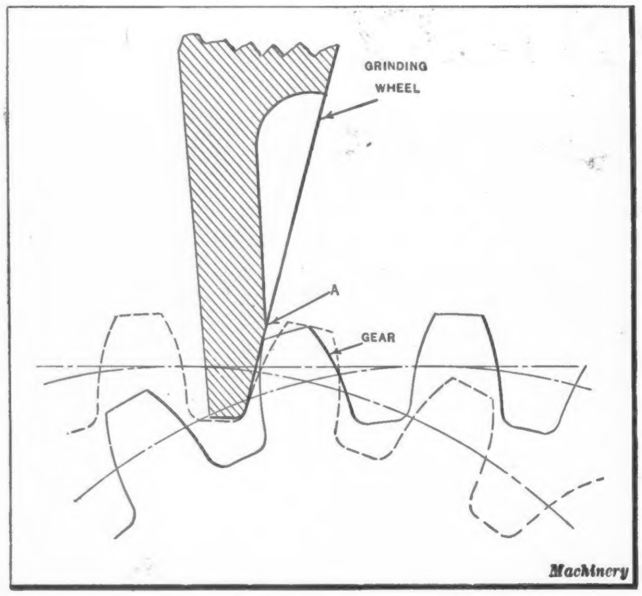


Fig. 1. Action of Gear Relative to Grinding Wheel on Machine of Generating Type

used in gear grinders and makes it possible to maintain a wheel face in a given plane.

Generating Type of Machine with Wheel that Grinds on Both Sides

A method of grinding gears by utilizing both sides of a wheel is illustrated by the diagram Fig. 2. The grinding faces of the wheel are shaped to represent a complete rack tooth instead of one side only. Since the grinding is not done by flat faces in this case, the wheel is given a traversing movement in a direction parallel to the axis of the gear. The wheel makes contact with only a small part of adjacent tooth faces during each stroke and after the return stroke the gear is indexed to locate the next tooth space in the grinding position. Corresponding parts or surfaces on adjoining teeth are ground until the gear has been indexed through a complete revolution; then a slight rolling motion is imparted to it so that the unground surfaces are presented to the wheel while the gear is indexed through another revolution. This intermittent rolling movement after each revolution of the gear is continued until the wheel has come into contact with all the tooth surfaces.

It will be understood that the teeth are given the correct curvature by rolling the gear beneath the wheel just as though the gear were rolling along a rack, and that this rolling motion relative to the wheel, is the same as is required in connection with the method illustrated in Fig. 1, except that it occurs intermittently. Means must be provided on a machine of this type for dressing both sides of the wheel to the pressure angle of the gears to be ground, and the width must be such that the right amount of stock is removed from the sides of adjacent teeth when the wheel is in the full-depth position. It is evident, therefore, that the width or distance between the angular grinding faces depends upon the pitch of the gears to be ground.

Generating Two Tooth Surfaces Simultaneously with Two Grinding Wheels

A method of grinding two tooth surfaces at the same time consists in using two wheels which operate in different tooth spaces, as shown by the diagram Fig. 3. The grinding may be done by using the flat side of each wheel, as indicated by the diagram, although very narrow edges may also be employed. This grinding side is inclined an amount equal to the pressure angle, the same as in the other generating methods referred to and in using flat surfaces, the wheels revolve in one position, as the gear blank is given a rolling motion for generating the tooth curves. The flat side of each wheel corresponds in location to the side of an imaginary rack tooth, and the generating action is the same as though the pitch circle of the gear were rolling along the pitch line of the rack, the motion being the same as with a single wheel. After grinding each pair of tooth faces, the gear is indexed a distance equal to the circular pitch. The amount removed in grinding is regulated by adjusting the distance between the wheels.

If the grinding is done by using the narrow edges of saucer-shaped wheels, instead of relatively broad flat faces, the gear has, in addition to a rolling motion, a traversing movement parallel to the axis. The rolling motion serves to generate the tooth curves and the axial traverse brings the narrow edges of the wheels into contact with the entire surfaces of the teeth being ground.

Formed-wheel Method of Grinding Gear Teeth

The formed-wheel method (illustrated by the diagram Fig. 4) is based on the use of a grinding wheel having surfaces that are shaped to conform to the space between correctly formed gear teeth. This method is similar in principle to the use of formed cutters for cutting gear teeth, in that the shape of the grinding wheel is reproduced in the teeth.

The formed wheel is centrally located, so that each of the curved grinding faces occupies the same position relative to a plane intersecting the axis of the gear blank. When a machine of this type is at work, the sides of adjacent teeth are ground as the revolving grinding wheel is given a feeding movement parallel to the axis of the gear. After each return stroke the gear is indexed to locate the next tooth space in the grinding position. It is evident that the shape of the grinding surfaces must be maintained by some method that makes it possible to compensate readily for wheel wear; hence the wheel-truing device is especially important in a formed-wheel type of gear grinder.

General Character of Work Performed by Gear Grinders

When gears are hardened, the tooth curves are likely to be displaced from their true position, and correcting such distortion is one important function of a gear grinder. Another function is to insure uniform spacing and to correct local or surface errors. If tooth curves deviate, even slightly, from the true position, rapid accelerating and decelerating movements occur, instead of a smooth uniform movement as each tooth comes into mesh and passes along the line of action. This irregularity occurs with great rapidity when a gear is revolving at fairly high speed, and noisy operation is the result. Local surface errors also cause noise and excessive wear. According to one firm that has specialized in gear grinding, objectionable noises are caused by gear tooth errors of only 0.0003 inch. In the experience of another firm, 0.0002 inch is the maximum error

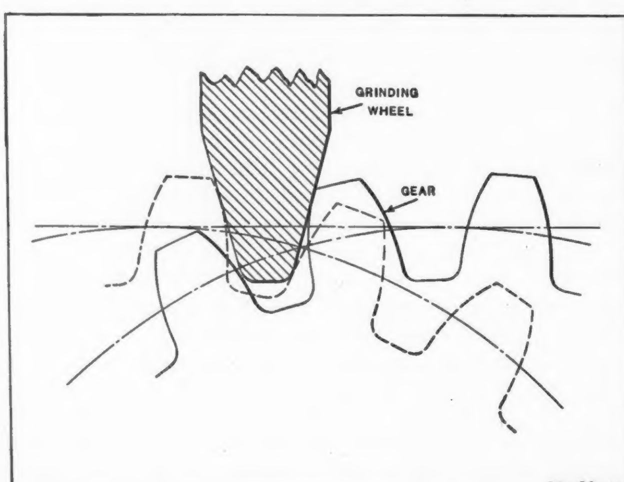


Fig. 2. Grinding Wheel which has Rack-tooth Section and grinds on Both Sides

acceptable to the users of the ground gears supplied by this company, and errors of 0.0005 inch result in unsatisfactory operation in the case of automobile transmissions.

Gear tooth grinders may be used for finishing gears as a regular part of the manufacturing process or for salvaging inaccurate gears that have been distorted excessively in hardening. In salvaging gears that were not intended to be ground, the grinding operation is performed simply to correct distortion. While this correcting process makes the teeth thinner than standard and introduces more backlash than is ordinarily allowed, the extra backlash may be entirely negligible in comparison with the distorted teeth and noisy operation of the unground gears. The grinding of hardened gears as a recognized means of finishing the teeth is the most important application of the process, and is being applied on an increasing scale.

Preparation of Gears for Grinding

When gear teeth are to be ground it is essential to regard this operation as one step in gear production, because the efficiency and cost of gear grinding depend in part upon performing gear-cutting operations with a view to the final grinding. This means that expensive finishing cuts, prior to hardening, may be eliminated, the gear-cutting being confined to roughing, since heat-treatment is sure to cause at least some distortion. This general practice is, of course, the same as that followed in connection with the use of other types of grinding machines. With gearing, however, it is important to use machines that are capable of accurate roughing, so that the grinding time will not be increased excessively on account of extreme errors in shape or spacing, or excessive grinding allowance.

Just how much stock must be removed in grinding gear teeth to compensate for the greatest distortion that is likely to occur varies for different gears and frequently is affected by the method of heat-treatment. As a general rule, the removal of 0.003 to 0.005 inch from each tooth face is sufficient to correct all distortion, and in some cases, the removal of only 0.002 inch is sufficient. These allowances are based on the assumption that the machine and cutters used for the preliminary cutting operation are of an approved type and in reasonably good condition. Incidentally, the grinding of casehardened gears does not remove enough of the hardened surface to injure the gear in any way, because the case is usually at least 0.025 inch deep and often has a depth of 0.035 or 0.040 inch. Prior to grinding the teeth, the bores of hardened gears should be ground; then if these gears are mounted on an accurately fitting arbor, it is possible to grind the teeth so that the pitch circle will be concentric with the bore, in addition to correcting local inaccuracies in tooth curvature or location.

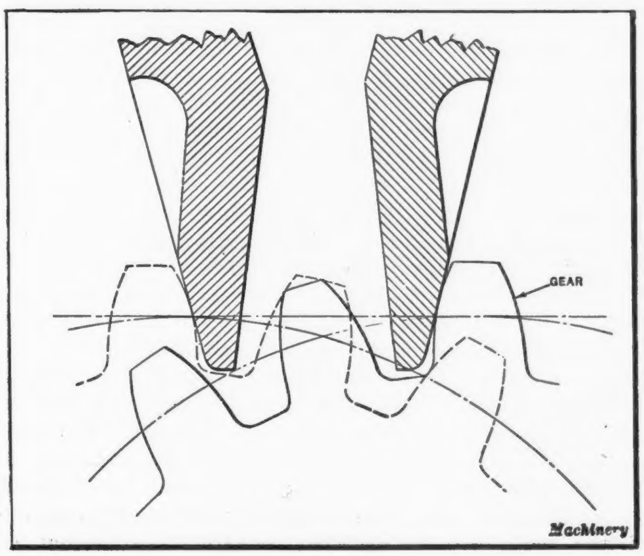


Fig. 3. Method of using Two Grinding Wheels on a Generating Type of Machine

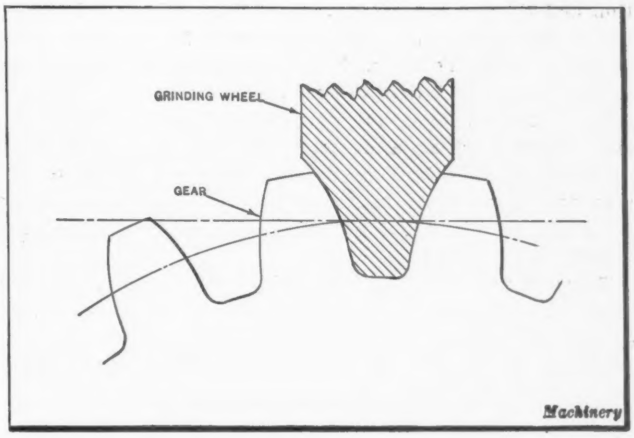


Fig. 4. Formed-wheel Method of Gear Tooth Grinding

Gear Tooth Grinding on Machine of Generating Type

An example of gear tooth grinding on a generating type of machine made by the Lees-Bradner Co., Cleveland, Ohio, is shown in Fig. 5. The grinding is done by the flat face of a large wheel, the machine operating in accordance with the principle represented by the diagram Fig. 1. The grinding wheel is set to the pressure angle of the gear, which, in the automotive industry, is usually 20 degrees. The wheel is also adjusted vertically in accordance with the diameter of the gear to be ground, and the gear is locked on the work-arbor in position to mesh with an imaginary rack represented by the wheel face.

As explained previously, the grinding side of the wheel on a generating type of machine represents the side of a rack tooth, and as the gear is being ground it must roll past the wheel just as though it were rolling along an accurately formed rack. This rolling motion is extended far enough to move one tooth into and out of engagement with the wheel, and as this occurs, the side of the tooth is ground; during the return movement a light cut is taken over the same side. At the end of the return stroke, the work-spindle and gear are indexed automatically so as to present the next successive tooth to the wheel, a large index-plate with accurately spaced divisions being mounted on the end of the work-spindle.

The generating motion, followed by indexing, continues automatically until the gear has made a complete revolution, or, in some cases, two revolutions. As the grinding wheel is 30 inches in diameter it does not require a traversing movement in the direction of the axis of the gear. Gears that are to be run in one direction only are sometimes ground only on the working faces of the teeth, but when both sides must be finished, which is the usual practice, the gears are reversed on the arbor for finishing the second side.

In order to derive the rolling motion referred to, a segment *A*, Fig. 6, is attached to the sleeve that surrounds the work-spindle, and is locked to the sleeve through an indexing mechanism so that it rotates relative to the sleeve only when indexing. The radius of this segment equals the pitch radius of the gear to be ground minus an allowance to compensate for the thickness of the steel tapes that govern the rolling motion. Four tapes are used and these are attached to the segment, one pair extending to the right and the other to the left. The outer ends of each pair of tapes are held by fixed clamps, these fixed ends being on opposite sides of the spindle so that the tapes can wind and unwind on the surface of the segment as the latter receives an oscillating motion, and the carriage is thus traversed along the horizontal ways of the bed. The clamps for holding the ends of one pair of tapes are located at *B* in Fig. 6.

The oscillating motion is obtained from a worm-wheel segment which is attached to the work-spindle sleeve. This worm-wheel segment is engaged by a reversing worm and as it is rotated through part of a turn, first in one direc-

tion and then in the other, the winding action of the tapes causes the slide to move past the wheel in the manner described. It will be noted that the power is applied directly to the spindle and that the reciprocating movement of the slide is derived from the spindle rotation instead of the slide being used as a driving member. This is done in order to avoid lack of uniformity in the rotation of the gear due to variation in the load on the tapes as the gear teeth roll into and out of engagement with the grinding wheel.

The grinding surface of the wheel is dressed true by a diamond which swings in a plane perpendicular to the wheel axis. The diamond remains in one plane and the wheel is adjusted toward it, so that repeated dressing does not alter the position of the wheel face except possibly as the diamond may wear down slightly. The diamond is adjusted against a hardened steel block which establishes the plane of the grinding face of the wheel. The axial adjustment of the grinding wheel is controlled by a handwheel at the outer end of the wheel-spindle.

In setting up the machine, it is necessary to use an index-plate for the required number of teeth, and also a segment and tapes to suit the pitch diameter. After the wheel-spindle has been set to agree with the pressure angle of the gear and the head has been located vertically in accordance with the gear diameter, the gear is located on the work-arbor with one tooth in contact with the wheel face which is positioned by a stop on the adjusting handwheel. Another stop on the handwheel is used for locating the grinding wheel in the working position; a second grinding position is also provided but this stop is not used ordinarily. The grinding is done wet, the same as for steel grinding operations in general.

The wheel is redressed after grinding from one to six gears, depending upon the size of the gears and the amount of metal removed. The endwise adjustment for redressing is made by turning a smaller wheel located within the regular handwheel; consequently, the positions obtained by the handwheel stops are not affected when the wheel is moved toward the diamond for truing. The particular machine shown in Fig. 5 is used at the plant of the Lafayette Motors Corporation for grinding transmission gears. The amount of stock left for grinding varies from 0.004 to 0.006 inch per tooth, or from 0.002 to 0.003 inch on each side. The teeth are ground on both sides by reversing the position of the gear on the arbor.

The time for grinding a given amount of stock from a gear tooth on machines of this type varies according to the size of the gear, because a smaller gear requires a larger rolling or generating movement in order to present the entire surface to the flat face of the grinding wheel. On the Lees-Bradner machine, the time for grinding one side of a tooth (including the forward and return movements) usually varies between 7 and 10 seconds. As a general rule, the grinding time is figured on a basis of 10 seconds per side per tooth, which includes two passes and the indexing time.

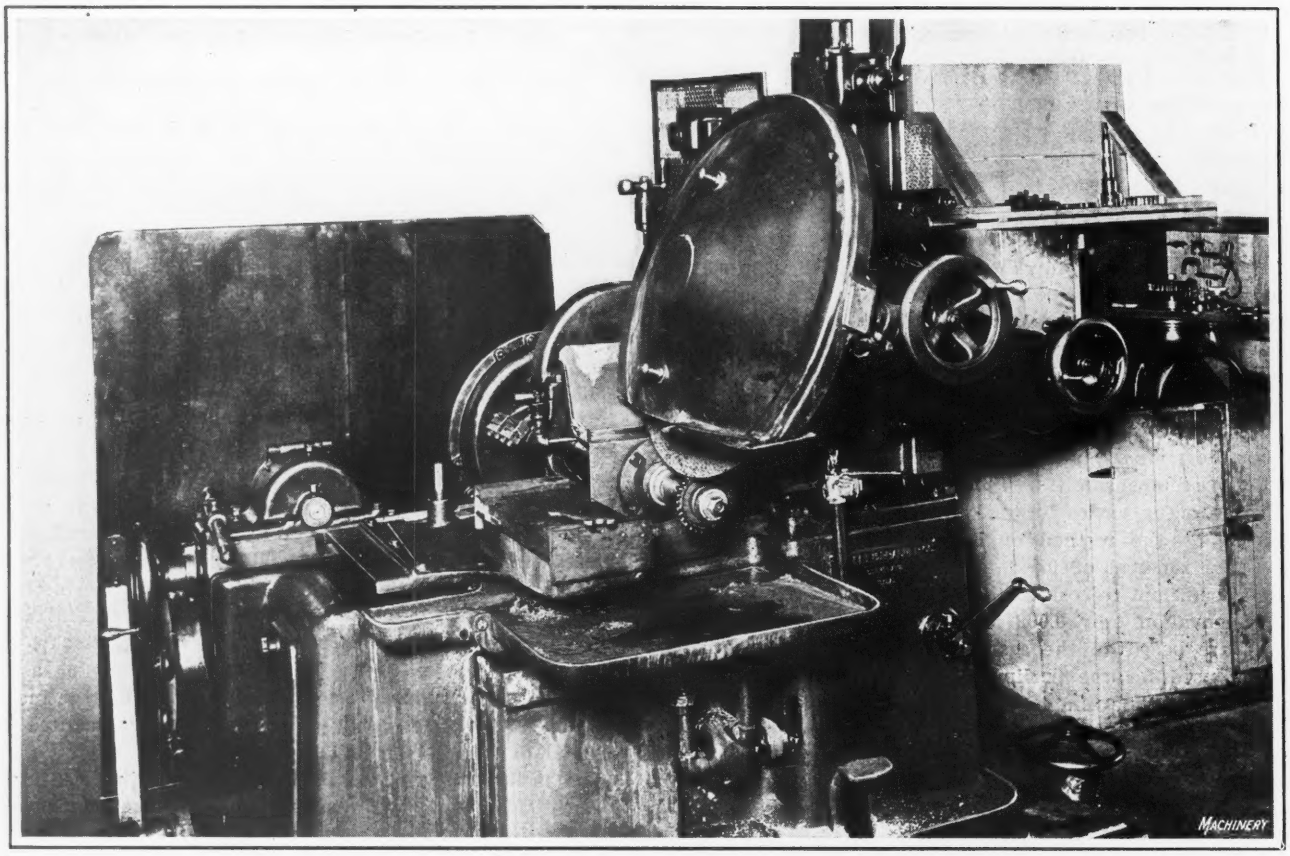


Fig. 5. Generating Type of Machine used for grinding Hardened Gears for Automobile Transmissions

Modification of Tooth Form to Meet Service Conditions

Although the involute curve meets the theoretical requirements for gear teeth, it has been demonstrated in the application of Lees-Bradner gear grinders that a slight modification in grinding is essential in order to obtain the best results when gears are running under service conditions. This modification, however, is extremely small (probably between 0.0002 and 0.0004 inch) and, incidentally, this indicates the degree of refinement possible both in grinding and testing gear tooth profiles.

The object of modifying the tooth curve is to compensate for the minute deflection of gear teeth while under load. In other words, the idea is to so grind the teeth that the curves will conform to true involutes during the meshing or working period. The nature of the deflection will be more apparent if we consider a driving tooth in contact with a driven tooth which offers considerable resistance to rotation. Evidently the driving tooth will be deflected backward relative to its direction of rotation, whereas the driven tooth will be deflected forward. The amount of deflection will vary with the tooth form, being greater for a small number of teeth than for a larger number, and

there are other factors entering into the problem. Hence the modification in actual gear grinding practice is based upon tests made under working conditions. After the required modification has been determined, it may be duplicated, as a precision gear testing machine has been developed by the Lees-Bradner Co., which makes it possible to chart whatever slight changes may be required for a given transmission. For a description of this gear testing machine, see April, 1923, MACHINERY, page 649.

On the Lees-Bradner machine, tooth curves may be changed by varying the rotation of the gear relative to the slide travel. For instance, a shim may be used to change the position of the tape segment relative to its axis of rotation, this shim being placed between a flat surface on the segment supporting sleeve and another flat formed within the segment bore. Thus, by merely shifting the segment without changing its radius, the central portion of the tooth curve may be ground a little low; or, if the segment radius is smaller than standard, the result is a curve low at both the point and root of the tooth.

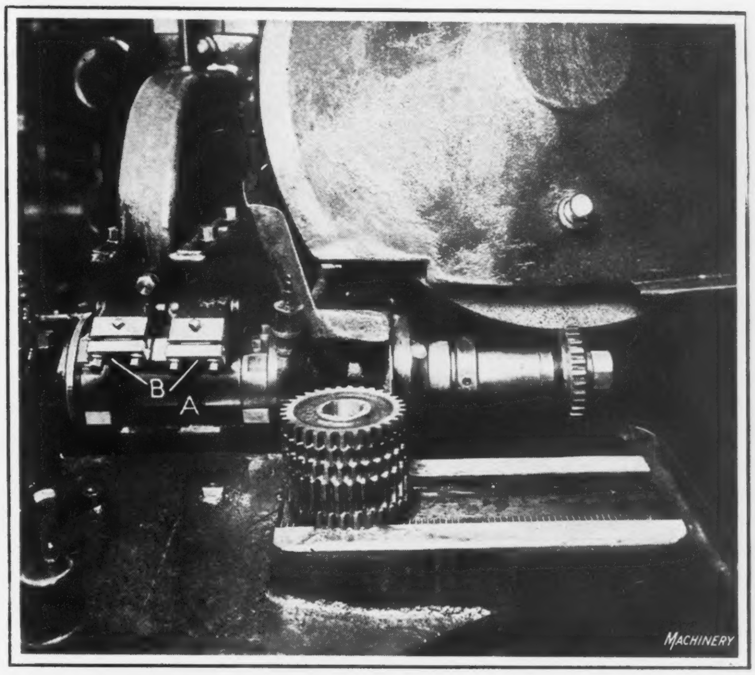


Fig. 6. A Gear Grinding Operation on a Machine of the Same Type as that shown in Fig. 5

If it were desired to so modify a driving tooth as to compensate for backward deflection, this could be done by setting the grinding wheel to a slightly smaller pressure angle for grinding the forward faces of the teeth and to a slightly greater angle for grinding the opposite or rear faces. However, if this method is applied, the result will be as follows: A given tooth on the driving gear is deflected back to its true position while under load, and the mating driven tooth is deflected forward slightly; consequently the following driven tooth will lag slightly and, as the following driving tooth has been ground full on the leading side, but is not yet under load, these teeth on the driving and driven gears will engage before they should. For this reason, the same modification is made on each side of the tooth in actual practice, there being a slight addition near the points of the driving teeth and a slight relief near the points of the driven teeth. The modification in any case is very slight, and the variation from a true involute can be detected only by precision apparatus.

Gear Grinder Equipped with Wheel having Rack-tooth Section

The gear grinder that will now be referred to is a generating type, made by the Garrison Gear Grinder Co., Dayton, Ohio, which is designed to finish simultaneously both sides of the teeth at one chucking by using a single grinding wheel. This grinding wheel has a rack-tooth section (as explained in connection with the diagram Fig. 2) and grinds on both sides as it is traversed through successive tooth spaces by a horizontal ram or slide which is given a reciprocating motion (see Fig. 7). When the grinder is in operation, the generation of tooth curves is accomplished as the result of an intermittent rolling motion which occurs progressively at the completion of each revolution of the gear.

On the outer end of the work-arbor there is a master gear *A* (see Fig. 8) having the same number of teeth and the same circular pitch as the gears to be ground. A master rack *B* attached to a slide is held solidly in mesh with the master gear on the work-arbor while the grinding wheel is in contact with the work, so that the work-arbor is held rigidly. As the wheel leaves the work on the return stroke, the master rack is automatically lifted and held out of mesh by a cam-actuated slide, while the work-arbor is indexed to locate the next tooth space in alignment with the wheel. Then the rack again meshes with the master gear, thereby correcting any error in indexing and locking the work-arbor just before the wheel enters the tooth space on its forward stroke.

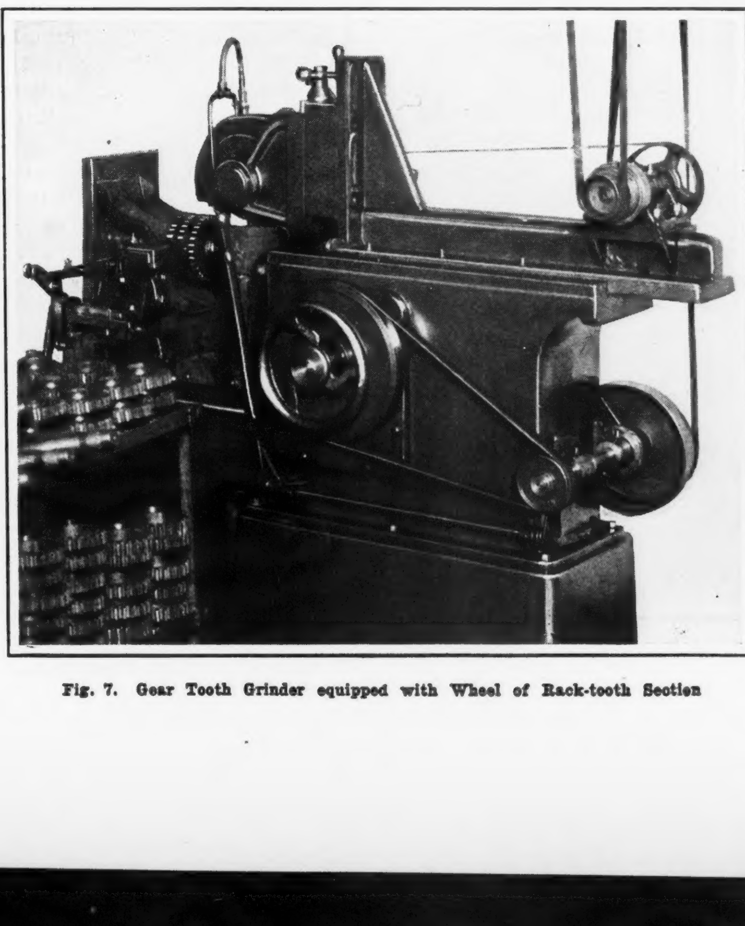


Fig. 7. Gear Tooth Grinder equipped with Wheel of Rack-tooth Section

The gears being ground are indexed one complete revolution without changing their axial relation to the grinding wheel. After the gears have made a revolution, the table, which supports the work-head, is automatically moved transversely a predetermined distance, thus causing the master gear to roll slightly along the master rack; consequently, the work-spindle and gear, or gears, being ground are also rotated slightly relative to the grinding wheel. After a series of these movements, the gear being ground will have passed to the opposite side of the grinding wheel, and both sides of all teeth will be finished as the result of this generating action. The pressure angle of the master gear is 20 degrees, but gears of any pressure angle ranging from 8 to 25 degrees and having the same circular pitch and number of teeth may be ground with one master gear.

Three methods of chucking gears are illus-

trated in Fig. 9. The gear shown at *A* is integral with its shaft, and is held by an external thread at the inner end. At *B* a tapped hole in the end of the gear shaft is utilized, and at *C* three gears having holes in them are mounted on an arbor. In grinding gears that are integral with their shafts, such as main drive pinions in automobile transmissions with face widths up to 3 inches, one gear is ground at a time, but gears having holes may be ground in multiple, as indicated by the diagram at *C*. When unground gears are locked in position, a locator *C*, Fig. 8, mounted on the work-table, serves to locate the teeth relative to the wheel so as to insure the removal of an equal amount of metal from the sides of the teeth.

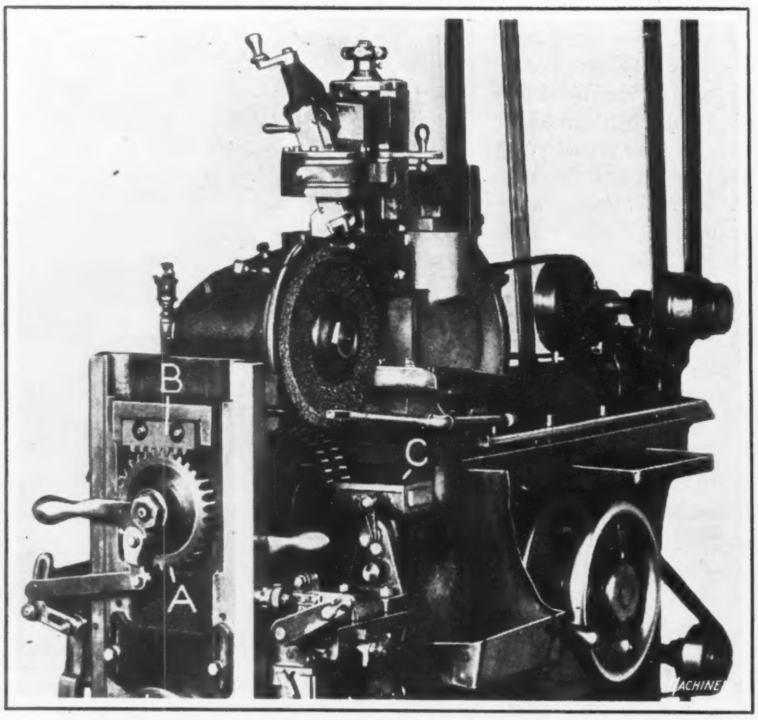


Fig. 8. Front View of Machine illustrated in Fig. 7, showing Master Gear and Rack Mechanism for controlling Indexing and Generating Movements

The wheel is maintained at the correct angle and thickness by a manually operated wheel-dresser which is mounted on the knee of the machine shown in Fig. 7, and is located so as to be under the center of the wheel when the ram is in its rear position. Another arrangement is shown in Fig. 8, the wheel-dresser of this machine being on top of the wheel-head, so that the wheel can be dressed with the ram in any position. In setting up the machine, each side of the wheel is dressed to agree with the required pressure angle, the cross-sectional shape of the wheel conforming to that of a rack tooth proportioned according to the pitch of the gears to be ground. Two wheel-truing diamonds are used; one is for dressing the angular sides of the grinding wheel, and the other for dressing the edge or outside diameter of the wheel.

In truing a wheel, the dresser slide is lowered sufficiently to allow the diamonds to true the worn surfaces. One diamond is first traversed across a side of the wheel by rotating the small crank seen in Fig. 8 at the top of the slide; then a rotatable member of the dresser head is indexed by hand one-half revolution, thus locating the dresser bar in position for truing the opposite side of the wheel. While the dresser head is being indexed, the other diamond is passed across the periphery of the wheel to dress it in correct relation to the sides. The average time required for wheel dressing is about thirty seconds.

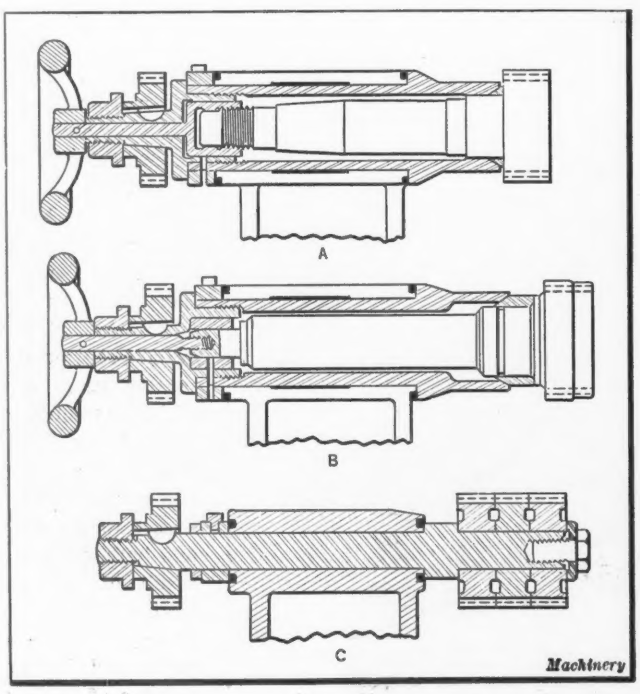


Fig. 9. Methods of holding Work on Gear Grinder of Type shown in Figs. 7 and 8

After truing the wheel, the reading on the graduated collar of the dresser-slide screw is noted, and then the wheel-head slide is lowered until the reading is the same on its graduated collar. This locates the lower side of the wheel in its original position, so that the wheel-truing operation does not interfere with the grinding of duplicate gears. In fact, successive gears are finished to a given size and tooth form without measuring or adjusting other than to compensate possibly once or twice a day for the extremely slight wear of the diamonds. When the inaccuracies are slight and the grinding allowance small, the gears may be finished in one cut, whereas when the inaccuracies or the grinding allowance is comparatively large, gears are finished by two cuts in one chucking. First, there is a roughing cut with a coarse feed; then, after dressing the wheel, a finishing cut is taken with a finer feed. If both roughing and finishing cuts are to be taken, the amount of metal, in thousandths, to be left for the finishing cut, will be indicated by the difference in the readings of the two graduated collars previously referred to. If two cuts are taken, the wheel is trued just before starting the finishing cut on each set of gears.

After the gears are ground, the machine stops automatically (except the grinding wheel) with the ram in the rear position, so that the wheel is out of the way and does not interfere with loading and unloading. One advantage claimed for this intermittent method of grinding is that there is no danger of gear distortion on account of local heating, because the gear is indexed after each passage of the wheel, which only grinds a small part of the surface per stroke.

Two-wheel Type of Gear Tooth Grinding Machine

The gear tooth grinder shown in Fig. 10 is equipped with two wheels for grinding two tooth surfaces simultaneously. This machine (which is made in Switzerland) is one of a number used at the plant of the Pratt & Whitney Co., Hartford, Conn., for grinding the teeth of Maag gears. The generating principle is utilized, and the gear being ground rolls first in one direction and then in the other, past the two grinding wheels, which are inclined in opposite directions to suit the pressure angle of the gearing, as illustrated by the detail view Fig. 11. In addition to a lateral rolling motion, the gear is traversed in an axial direction, in order to bring the entire surface of a tooth into contact

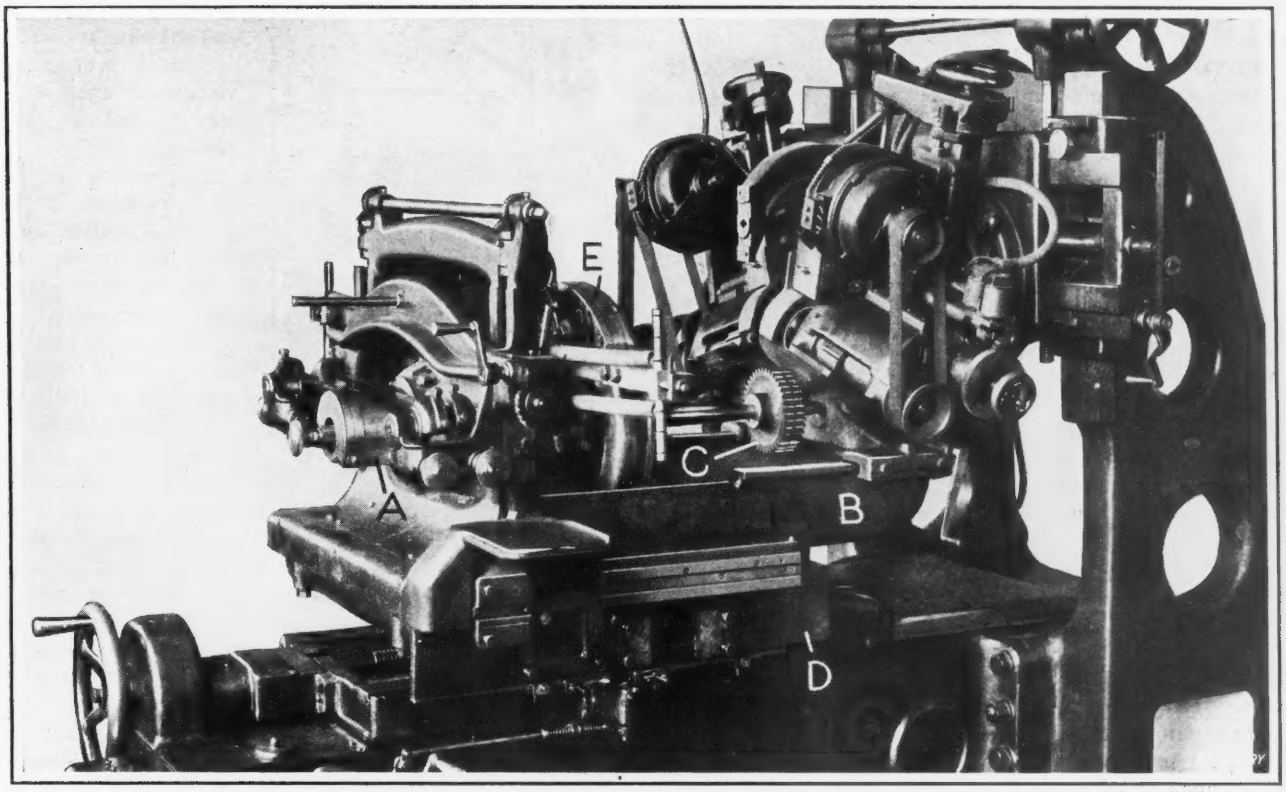


Fig. 10. Two-wheel Type of Gear Tooth Grinder used for grinding the Teeth of Maag Gears

with the edges of the grinding wheels. The traversing movement of the work during each short rolling motion depends upon the finish required, and is usually about 1/10 inch for finish-grinding a tooth of medium size. After the gear has been traversed far enough in one direction to clear the wheels, it is automatically indexed one tooth by the mechanism located at *E*, Fig. 10; the traversing motion is then reversed and the grinding continues during the return stroke.

Saucer-shaped wheels are used on this machine, and the active grinding surfaces are narrow edges giving little more than a line contact. The object of using a narrow grinding edge instead of a comparatively broad flat surface is to facilitate keeping every part of the active surface in the correct grinding plane by the automatic wheel-positioning mechanism provided. The grinding wheels are usually located in adjacent tooth spaces, although both wheels might occupy the same tooth space when the pitch is large enough to permit this.

Steel bands in conjunction with pitch drum *A* on the work-spindle sleeve are used to control the rolling motion that accompanies the lateral reciprocating movement of slide *B*. Slide *D*, upon which slide *B* is mounted, is traversed in a direction parallel to the axis of the work-spindle and slowly feeds the work while it is rolling past the grinding wheels. The wheel wear is compensated for by a very sensitive electrical mechanism which advances the wheels 0.00004 inch at a time as often as they wear that amount. The diamond for each wheel is carried by a pivoted arm, and every few seconds the diamonds automatically advance to the grinding edge of the wheels. If the edge is still in the true plane, the diamond touches it and no further action occurs, but if

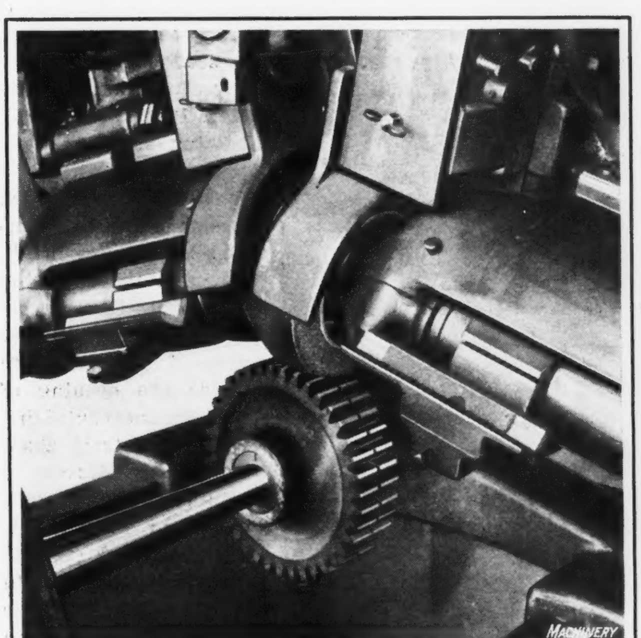


Fig. 11. Detail View of Grinding Wheels on Machine shown in Fig. 10

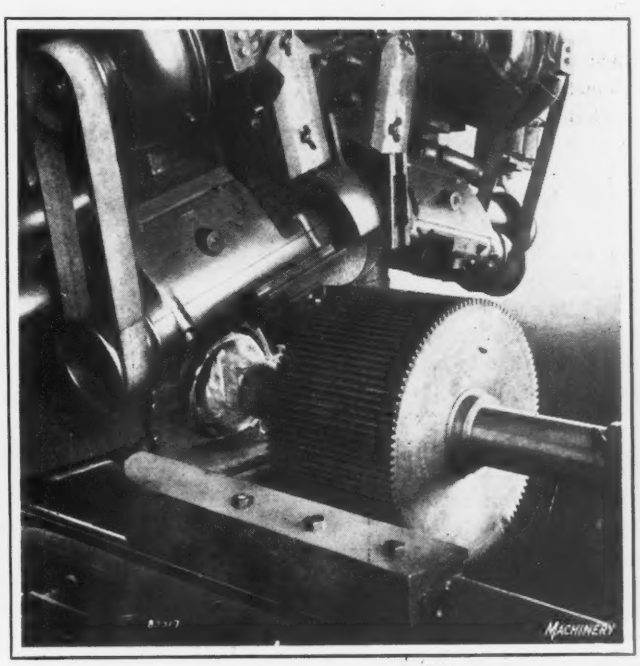


Fig. 12. Grinding a Wide Gear on Machine of Type shown in Fig. 10

there has been a slight amount of wear the additional movement of the diamond-holder causes an electrical contact to be made and the wheel is automatically adjusted toward the diamond 0.001 millimeter or 0.00004. The diamond presents a flat face to the wheel and does not cut or true the worn surface, but merely "feels" its position in order to control the wheel adjustment automatically. The wheel is trued by hand when necessary.

Each grinding wheel is driven by an independent motor. The slide or saddle that carries the wheel-spindle and supports the driving and automatic positioning mechanism has an angular adjustment to permit setting the wheel to conform to the pressure angle of the gear to be ground. This machine is intended more particularly for grinding wide-faced gears requiring a traversing movement. An example of this class of work is shown in Fig. 12, which represents a detail view of a machine set up for grinding a high-speed reduction gear having 108 teeth of 8 diametral pitch, and a face width of 8½ inches. This machine is relatively slow for gears of small face width. It is claimed that gears ground with this machine are operating successfully at circumferential speeds as high as 10,000 feet per minute, which indicates the degree of accuracy that is obtainable.

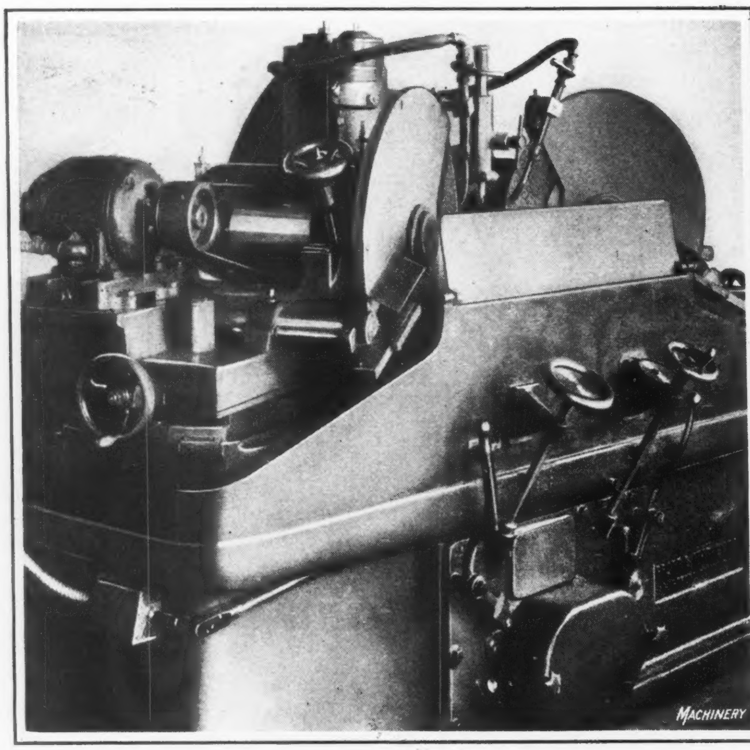


Fig. 13. Two-wheel Gear Tooth Grinder of the Rotary Type

Rotary Type of Gear Tooth Grinder

A gear tooth grinder recently developed by the Pratt & Whitney Co. is illustrated in Fig. 13. This machine may be designated as a rotary type, because the gear being ground rotates continuously in one direction and its action is regulated in such a way that all the tooth surfaces are finished without employing an intermittent indexing movement. A master gear and rack mechanism is utilized to control the generating movement and to bring the gear into contact alternately with the two 24-inch grinding wheels with which the machine is equipped. The grinding is done by flat faces on these wheels which revolve about fixed axes and are not traversed parallel to the axis of the gear being ground. The stock left for grinding is removed by taking twenty or thirty light cuts per tooth, instead of removing the same amount of stock in one or two cuts. The grinding is done wet and the cuts are widely separated, which is a safeguard against errors caused by local heating.

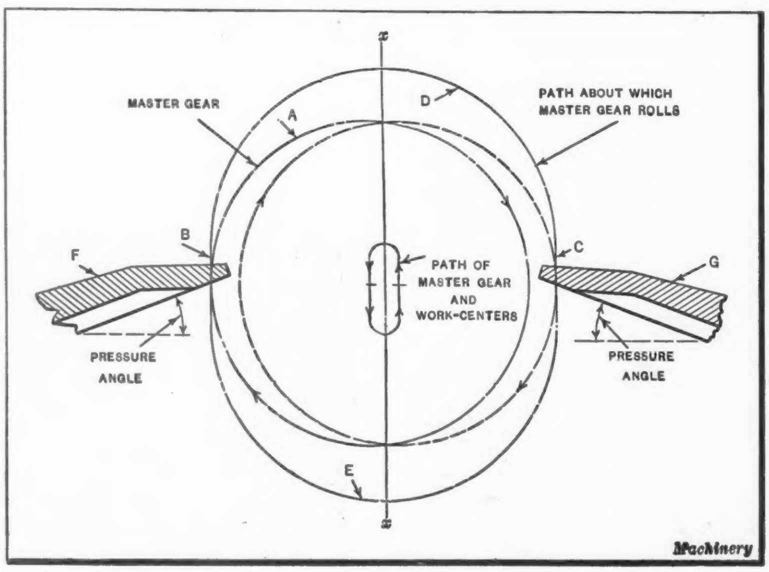


Fig. 14. Diagram illustrating Action of Master Gear and Work relative to Grinding Wheels on Rotary Type of Machine

The action of the gear relative to the grinding wheels is illustrated by the diagram Fig. 14. A master gear, represented by pitch circle *A*, with the same number of teeth and pitch as the gears to be ground, is caused to roll about a path formed of short rack sections at *B* and *C*, and two halves of an internal gear at *D* and *E*. The work is located above the master gear and in alignment with it, the work-holding fixture being so arranged that the work has the same rolling motion as the master gear. The gear to be ground is at the same height as the grinding wheel centers. When the master gear is rolling along rack section *B*, a tooth on the work rolls into and out of contact with the flat face of the left-hand grinding wheel *F*; the master gear then rolls around the half internal gear *E*, and as it passes along rack *C* on the other side, the face of another tooth engages the right-hand wheel *G*. The relation between the number of teeth in the master gear and the total number of teeth around the toothed track about which the master gear rolls is such that a cut over a given tooth face is not followed by another cut until all the other teeth have had similar cuts taken on both sides.

The arrangement of the work-holding fixture and the master gear mechanism is shown in detail in Fig. 15, the water guards having been removed and the work-head raised out of the operating position. The hardened and ground master gear is at *A*, and the gear to be ground is mounted on an arbor between centers carried in two freely swinging arms which confine the line of centers to parallel positions. The lower end of this arbor may be seen at the upper part of the illustration. Part *H* is a ball-bearing, and *J* is a pin that is free to turn in the work-spindle which is mounted in ball bearings inside of casing *K*. When in the operating position, the work-head is lowered so that parts *A*, *H*, and *J* are inside the opening of the fixture containing the toothed track about which gear *A* rolls. A plan view of this track is shown in Fig. 16. The short rack sections (previously referred to in connection with the diagram Fig. 14) are shown at *B* and *C*, and the internal gear

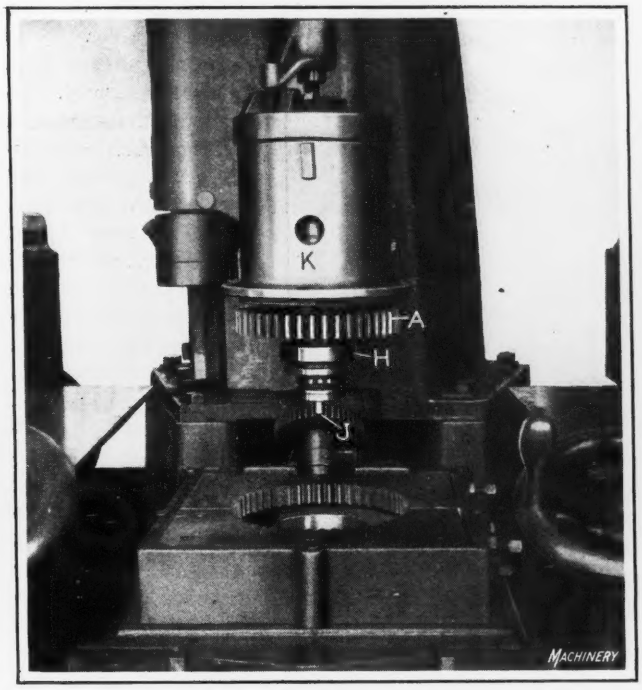


Fig. 15. Master Gear A and Toothed Track below, which governs Action of Master Gear and Work

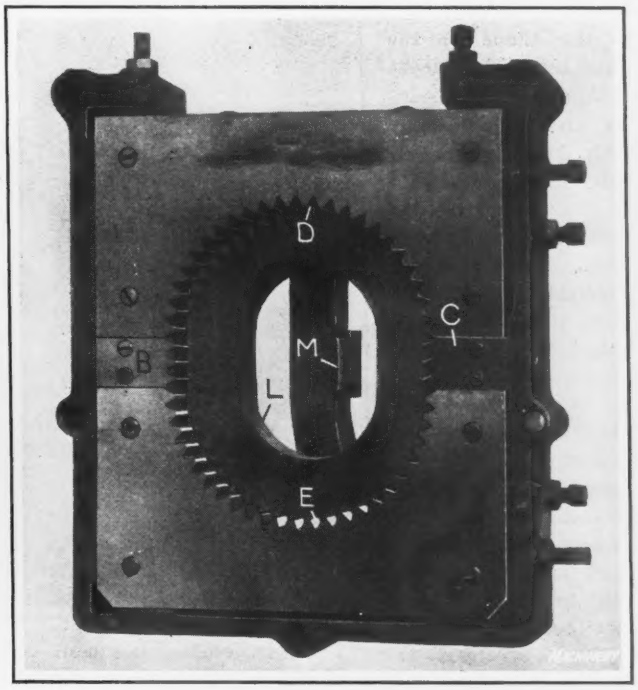


Fig. 16. Plan View of Toothed Track about which Master Gear, shown in Fig. 15, rolls

sections at *D* and *E*, the reference letters corresponding to those used in the diagram. Ball bearing *H* (Fig. 15) rolls around the smooth track *L* (Fig. 16), whereas pin *J* rolls around the tongue *M*, thus confining the motion of the gear to be ground to this path.

The two views, in Fig. 17 show how the gear comes into engagement first with one grinding wheel and then with the other. The gear at the left is rolling toward the observer, and the master gear below is in the position represented by pitch circle *A*, Fig. 14. The right-hand view in Fig. 17 shows the gear rolling away from the observer, the master gear now being in engagement with the opposite side of the track. The particular gear shown in Fig. 17 has 43 teeth of 7 diametral pitch, and the internal gear path about which the master gear rolls has 54 teeth.

After the gear describes the forward and return rolling movements indicated by the illustration, the next forward movement brings a tooth into contact with the wheel that is 11 removed from the one previously ground ($54 - 43 = 11$). The relation of 11 and 43 is such that a cut is taken over both sides of all the teeth of this gear before the tooth first ground again comes into contact with the wheels. The action is continuous until the gear is finished, an automatic feed and stop movement advancing the work to the wheels until the desired tooth thickness is obtained. This feeding movement, which is only slightly more than the thickness of stock to be removed and does not exceed 0.006 to 0.010 inch, is applied to the entire master gear and work-holding fixture, and is in the direction of the center line *xx*, Fig. 14, and toward the grinding faces of the wheels. The amount of stock removed from a tooth at each revolution never exceeds 0.0002 to 0.0003 inch, and each contact with the wheel is widely separated from the preceding one. Furthermore, if the work springs from the pressure of the wheel, this does not affect the action of the other wheel; consequently, errors from local heating or from the deflection of the work or wheels are minimized. The wheel wear is uniformly distributed around the work, and there is no perceptible variation between the first and last tooth ground. This method of grinding the teeth by taking a series of twenty to thirty light cuts per tooth is made possible by the continuous rotary motion, which permits taking 150 cuts per minute on each side of the teeth of a gear.

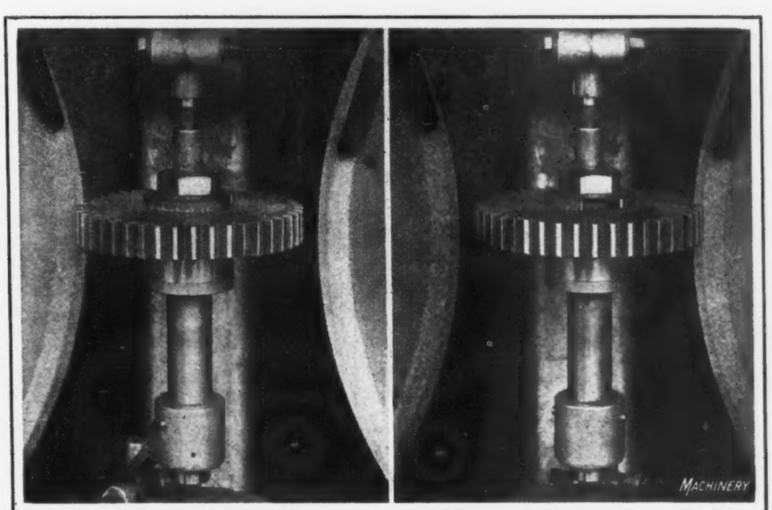


Fig. 17. Views showing how the Gear is alternately brought into Contact with the Two Grinding Wheels

This machine is adapted for grinding the various sizes of spur gears used in automotive transmissions. A separate fixture is required for each diametral pitch and tooth number, but the pressure angle, tooth depth, and tooth thickness may be varied at will by adjusting the position of the wheel-slides. The width of face that can be ground is limited to about 1½ inches, since the wheels do not have a traversing movement. The operator dresses the wheel to compensate for wear while a gear is being ground, and this truing operation is usually required after every third or fourth gear. A fixture is provided for locating an unground gear on its arbor outside of the machine. Gears of the accuracy usually required in the automotive industry may be ground at the rate of ten to fifteen seconds per tooth, depending somewhat upon the amount of stock left for grinding. The highest degree of accuracy and finish is obtained by grinding several times around the gear after the feed stops, in which case the floor-to-floor time may be extended to 20 seconds per tooth.

Gear Grinder of Formed-wheel Type

The gear tooth grinding machine shown at work in Fig. 18 has a wheel that is formed

on the grinding edge to the shape of the space between adjacent teeth, so that two sides are ground simultaneously. This machine, which is the type used by the Gear Grinding Machine Co., Detroit, Mich., embodies the principle previously referred to in connection with Fig. 4. The grinding wheel used is carried by a horizontal ram that is given a feeding motion to traverse the wheel through the tooth spaces. This machine has been designated as the "shaper type" to distinguish it from the "planer type" which is arranged to traverse the work past the wheel and is adapted for large heavy gearing.

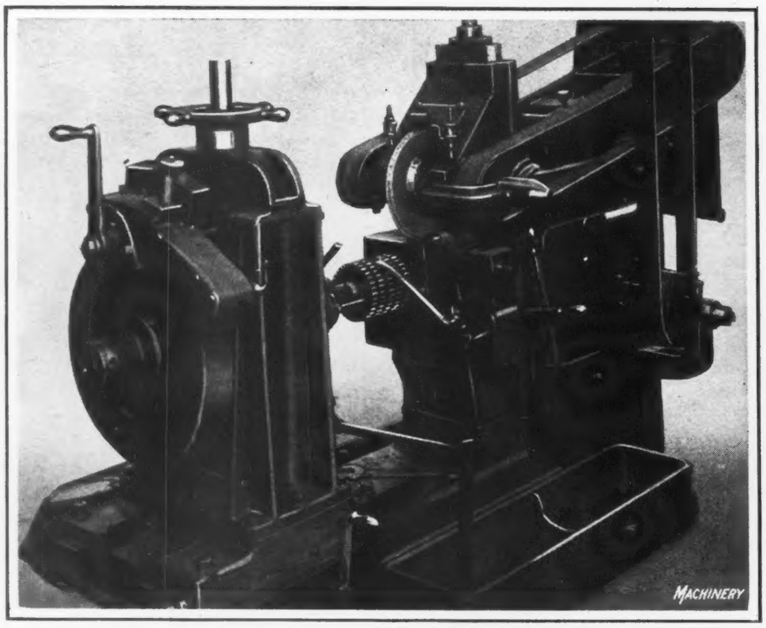


Fig. 18. Grinding Five Gears simultaneously on Formed-wheel Type of Gear Tooth Grinder

As a general rule, more than one gear is ground at a time on these machines, the number depending upon the width of the gears. The general method of using this machine is to rough-grind all of the teeth to within 0.001 or 0.002 inch of the finished size. This rough-grinding is accomplished by one passage of the wheel through each tooth space, and after the principal distortions have been corrected in this manner, the wheel is trued for taking a light finishing cut, and it is not retrued until after the roughing operation on the next arbor of gears. The indexing movement for grinding each successive tooth space takes place after every return stroke of the grinding wheel.

The grinding surfaces of the wheel are given the required shape by mechanically guided diamonds, which are located beneath the wheel when the latter is at the rear end of the stroke. One pair of diamonds is used for truing the curved sides of the wheel, and a single diamond for truing the edge or periphery. Accurate indexing of the gear is controlled by a large index-plate mounted directly on the work-spindle and having notches that are engaged by a locking bolt or plunger.

The machine illustrated in Fig. 18 is grinding five gears simultaneously. By grouping these gears in this manner, it is possible to grind 2500 teeth of 7 diametral pitch in nine hours. These gears, as roughed out on the gear-cutting machine, have a grinding allowance on each side of the teeth of approximately 0.005 inch. An interesting application of the formed-wheel process is shown in Fig. 19, which illustrates the use of a small formed wheel for grinding cluster countershaft gears. This grinding wheel is only 2 inches in diameter so that it can grind the 14-tooth gear without coming into contact with the adjacent gear, the space between the two gears being 1⅛ inches.

Application of the formed-wheel process to a special gear grinding operation is illustrated in Fig. 20. The gear in this instance is a helical type used in connection with a timing device. A standard column-and-knee type milling machine has been equipped for this operation by attaching a wheel-head to the face of the column and using an ordinary dividing head for holding and rotating the work the same as for helical milling.

The formed-wheel process has been applied to gears ranging from 30 to 1¾ diametrical pitch, with diameters varying from ¼ inch up to 53 inches, and face widths up to 21 inches. The general method of grinding is the same for this wide range of gearing, a formed wheel being used in practically the same manner as a rotary milling cutter, and providing means of finish-grinding the tooth surfaces as a substitute for the finish-cutting operation.

Cost of Ground Gears

In considering the cost of ground gears, as compared with unground gears, it is essential to take into account

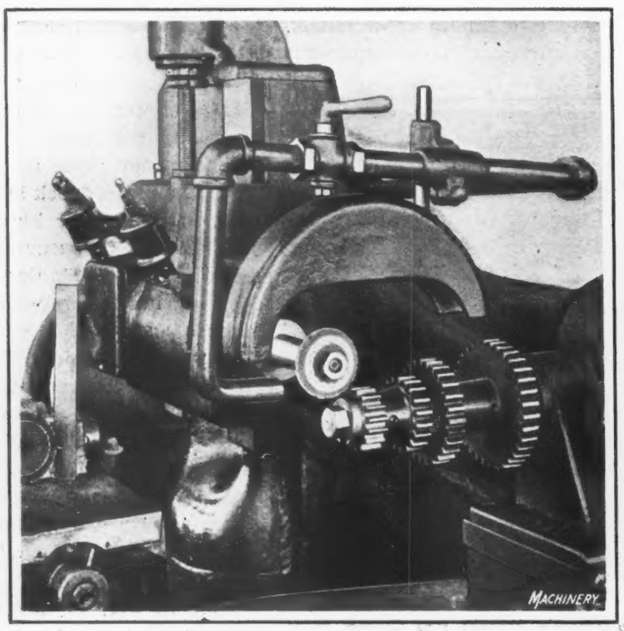


Fig. 19. Use of Small Formed Wheel for grinding Cluster Gears

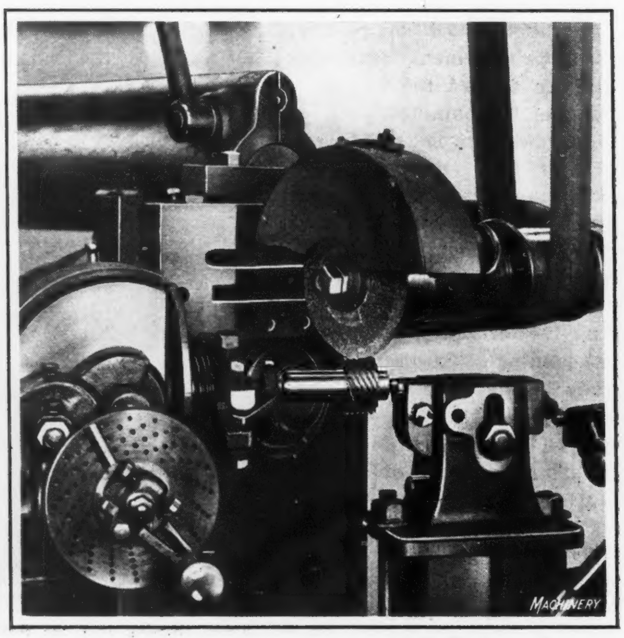


Fig. 20. Formed-wheel Process applied to Helical Gear Grinding

all expense involved in obtaining finished transmissions that meet commercial requirements. In other words, the actual cost in each case should be based not only upon machining processes, but also upon relative scrap losses, and any time that may be required for dismantling transmissions that prove unsatisfactory, either under test or in service, should be included. Whatever cost reduction may result from the elimination of finish cuts in cutting gears that are to be ground after heat-treatment is another item of importance.

Estimates as to relative costs of ground and unground gears vary from higher costs for ground gears to lower costs. The consensus of opinion, however, seems to be that ground gears are economical, as applied in the automotive field to transmissions of the better grades, especially if all related expenses are considered. Owing to the number of variable factors that affect costs, it is not feasible to compile cost data that is applicable in different plants, especially in view of the variety of conditions that exist. In a paper presented by Glenn Muffly of the Lees-Bradner Co., before the Detroit section of the Society of Automotive Engineers, the question of cost is summarized as follows:

"A big item in the cost of transmission production is the tearing down and reassembling of gear-boxes on account of gear noise. This cost often extends beyond the transmission department to the chassis assembling department and even to the finished cars after shipment. These items of cost are entirely eliminated by the finish-grinding of the gear teeth after heat-treatment, provided, of course, that proper standards are adhered to and the gears are tested for tooth form and spacing before assembling. In some cases it has been shown that the saving in assembling costs, in inspection and rejections, was greater than the additional cost of grinding."

In connection with the discussion that followed, it was also pointed out that the process of heat-treatment becomes both simpler and cheaper in the case of ground gears: "Some manufacturers are going to considerable additional expense for heat-treatment to hold the distortion down to a minimum. This expense can be avoided. Other manufacturers have found it impracticable to use certain steels that possess very good physical properties, but do not finish smooth. Steels that may be less expensive than those used in the past can now be adopted as a grinding machine will put a good finish on them. Some manufacturers use low-carbon steels and go to considerable expense to carburize the gears after roughing them, and then finish-cut and quench them from a comparatively low temperature to minimize the distortion. This expensive carburizing operation can be reduced or eliminated entirely by using different steels and by finish-grinding after heat-treatment."

In considering this general subject, it would, of course, be misleading to arrive at conclusions based upon a direct comparison of costs, because the quality of ground compared with unground gears is a factor that should be considered carefully and from every angle affecting the commercial value of the product.

* * *

BELTING CEMENTS

By LOUIS W. ARNY, Secretary, The Leather Belting Exchange, Philadelphia, Pa.

Two kinds of cement are used for joining the ends or plies of leather belting to produce what is generally termed an endless belt. One kind is referred to as "regular" belting cement and the other kind as "waterproof" belting cement. Both kinds can be obtained from the leather belting manufacturer, and either has ample strength and durability. When a belt is to be used in a dry place, where it is not subjected to moisture, the regular belting cement is employed, while the waterproof cement is used in damp places and where the belt comes in contact with water.

Regular Cement

The regular cement usually comes in cakes or lumps, which are dissolved in water in a double-jacketed glue pot. Any pot with a double jacket—that is, with an inner and an outer vessel, so that the heat reaches the cement through the medium of hot water, and not directly from the flame, will serve the purpose, though it is better to use the Safety or Underwriter's glue pot, for in it the glue may be maintained under heat directly at the job, and without risk of causing fire.

The cement should be made hot, but it should not be permitted to boil. It should be reduced with hot water to a proper consistency to spread easily, and must be applied "piping" hot, to get the best results. It is desirable too, that it should be applied fresh, and it is better not to attempt to use over the remains of a previous melting, if it is old and hard. The pot and the brushes must be kept clean, as the base of this cement is animal glue, which is subject to putrefaction.

Waterproof Belting Cement

The waterproof cement is entirely different. It is chemical, a base dissolved in a solvent other than water. The solvent is very volatile, and highly inflammable, and it must be kept away from any open light. It reaches the buyer in a liquid form, usually ready to spread, though after some spreading the remainder will grow thicker and should be reduced by the addition of solvent, which can be obtained from the same source as the cement.

This cement is more like a varnish, and it is used cold. The surface to be cemented must be thoroughly coated with the cement, well brushed into the fibers of the leather, and then permitted to dry, which, because of the volatility of the solvent, takes place rapidly. When dry, another coat is applied. This coat is spread lightly and is also permitted to dry. When the second coat is perfectly dry, the belt is ready for the third and last coat. Care must be taken to apply the cement evenly and not leave any bare spots. On belts wider than 12 inches, it is best not to attempt to cover more than a 5-inch cross-section of the belt at one time, since the solvent evaporates very fast, and it is easier to handle a small surface. When applying the last coat, the work must be done quickly. The joint should not be hammered, but rubbed gently or placed between boards, and pressure applied with the bench screws. The joint should "set" for a couple of hours or longer before using the belt.

The waterproof cement is essentially a liquid celluloid and its application places a layer of celluloid between the two surfaces of the lap, in which the leather fibers becom embedded. It is unaffected by water, in any period of time, because both its base and its solvent are materials that art not soluble in water. It should be used on all belts that are exposed to damp conditions, or on which water may leak.

Both of these cements are thoroughly practicable without the addition of any rivets, pegs, stitching, or other means intended to hold the plies of the belt together.

The occasion of taking a belt off the pulley for shortening or for repairs, always presents the opportunity of making a careful examination of it, particularly to see that it is being properly lubricated. A good leather belt requires no dressing on its grain, or pulley side to make it adhere to the pulley, for the natural grip of the leather makes an adhesion with the pulley that is quite sufficient to transmit its rated load, but the leather is composed of thousands of little fibers that are constantly working on each other, and that require lubrication in the same manner as other working parts. It is well to avoid the use of dressings which produce an artificial adhesion between the belt and the pulley, for most of them are injurious, and all of them unnecessary, a suitable lubrication of the fibers of the leather being all that is required.

Design of Wire-forming Dies

By W. B. GREENLEAF

THE bending of wire into various shapes in instances where a four-slide wire-forming machine is not available and where the quantity required is such that it would be uneconomical to do the bending by hand or in hand-operated machines, may often be advantageously accomplished on a punch press by the use of special dies. The present article describes a set of dies used in this manner for forming a bill file from 0.080-inch soft steel wire, which is furnished to the manufacturer in twelve-foot lengths. In the first operation, the wire stock is cut off to a sharp diagonal point at one end and this end is bent as shown at *A*, Fig. 1; the opposite end of the stock is cut square. The die used for this operation is illustrated in Fig. 2. The wire is fed across the die between guide pins until it comes in contact with a stop at the left. Then on the downward stroke of the press ram, it is cut simultaneously at two places by punch *A*, the end of the severed piece being cut diagonally and the end of the remaining stock being cut square as previously mentioned. It will be apparent that a small piece of scrap results. Punch *B* bends the end of the wire upward as punch *A* descends into the die-block. The two punches and the die-block are made of tool steel.

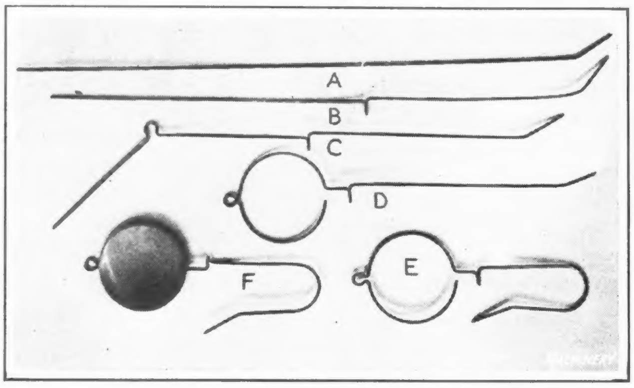


Fig. 1. Steps in producing a Wire Bill File on the Punch Press

Forming and Twisting a Loop

The next operation consists of imparting a double bend or loop near the middle of the wire, and then twisting the loop at right angles to the main section of the wire, as shown at *B*, Fig. 1. This is accomplished by means of the die illustrated in Fig. 3. The wire is laid across the die with one end against a stop to insure proper location of the loop. Punch *A* is made in three sections, two of which are semicircular. The third part *D* is flat and extends across the punch at the center. Both semicircular sections are cut away, as shown in the upper right-hand corner of the illustration, the parts, however, sloping in opposite directions. Thus, when the punch descends on the wire, the central section forces a portion of the wire into the die and forms the loop, and at the same time the sloping surfaces of the semicircular punch sections cause the ends of the wire to swing toward the front and back of the press. This action twists the loop, as desired. At the end of the stroke the cross-section of the wire is changed slightly near the loop by being pressed between the punch and part *C* in the die. This sets the wire, and eliminates the tendency to return to its former shape. Setting the wire in the manner outlined is an important feature of the dies here described.

The crankshaft of the press on which this operation is performed is run at the slow speed of 30 revolutions per minute. Faster operation would result in the wire ends being swung around so rapidly that undesirable bends would be produced between the loop and the ends. It was necessary to locate the die and punch forward of the center line of the press and to the left in order that the wire ends could swing freely. The punch members are made of tool steel, and are notched across their lower ends, to hold the wire in position at the beginning of the operation. The die members *B* and *C* are also made of tool steel, and are mounted in a machine-steel die-block. The punch is a snug sliding fit in ring *B*, and this serves to support the punch while the wire is being formed.

Forming a Second Loop and Bend

The loop and bend at the left-hand end of the wire at *C*, Fig. 1, are produced in the third operation by means of the die illustrated in Fig. 4. The wire is placed across the die between pins *C* and *E*, as shown in view *X–X*. A stop governs the position of the wire in relation to the length of the die. As punch *A* descends into die-block *B*, a portion of the wire is curved around pin *C* by the sloping surface of the punch, the two ends of the wire swinging toward

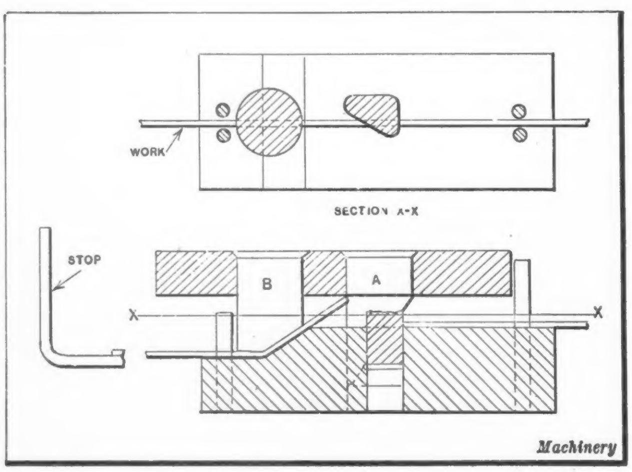


Fig. 2. Die employed for cutting the Wire from the Stock and bending One End

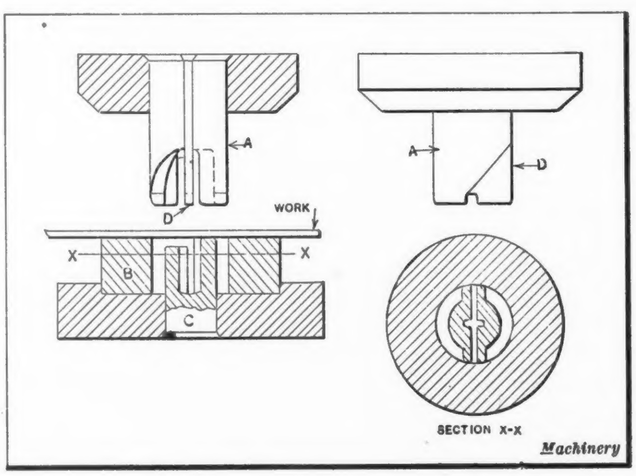


Fig. 3. Tools for forming a Loop and twisting it at Right Angles to the Straight Section

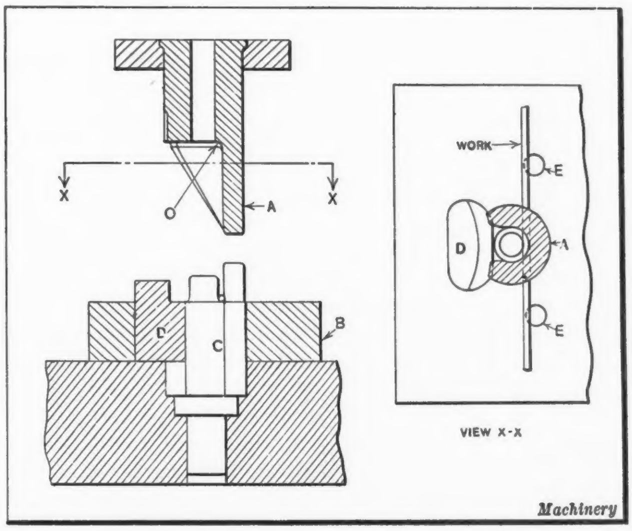


Fig. 4. Punch and Die that produce the Loop and Bend at the Left-hand End, as shown at C, Fig. 1

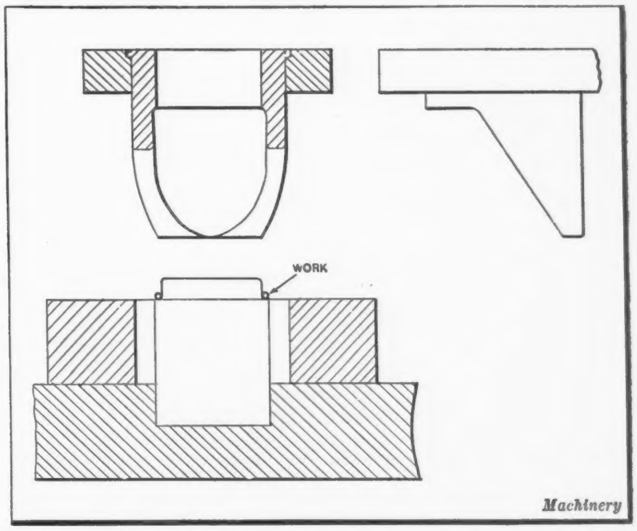


Fig. 5. Die employed in the Final Punch Press Operation for bending back the Hook

the front of the press until they come in contact with block D, thus forming the bend. At the end of the stroke, the wire is set by squeezing the loop slightly between the upper shoulder of pin C and shoulder O of the punch.

Punch A and die parts C and D are made of tool steel, and die-block B is made of machine steel. The punch and die members of this set, as well as those of the dies used in the two succeeding operations, are held in alignment by 1-inch guide pins, which are not illustrated.

Final Operations on the File Wire

The large ring at the left-hand end of the wire, as illustrated at D in Fig. 1, is produced by means of the die equipment shown in Fig. 6. This die is identical, as regards the principle of operation, with the die just described. However, owing to the fact that the ring was so large and the stroke of the press was only 2½ inches, considerable trouble was experienced in sloping the forming surface of the punch so that the ring would be produced without cutting the wire. In placing the work on the die for the operation, the loop produced in the preceding step is laid over pin B, and it is drawn together as punch A descends by tongues O. Pin B retains the shape of the loop during this operation. The ring is formed around block E by the sloping surfaces of the punch, the long end of the wire swinging forward until it comes in contact with pin C.

Two strokes of the press are necessary to bring the straight section of the wire approximately in alignment with the loop of the ring. In the first stroke, the straight section comes in contact with surface F on the front of the punch, this surface having a generous round where it joins the inside of the punch. Prior to the second stroke, the wire is turned over on the die, and thus comes in contact with surface G at the next descent of the ram.

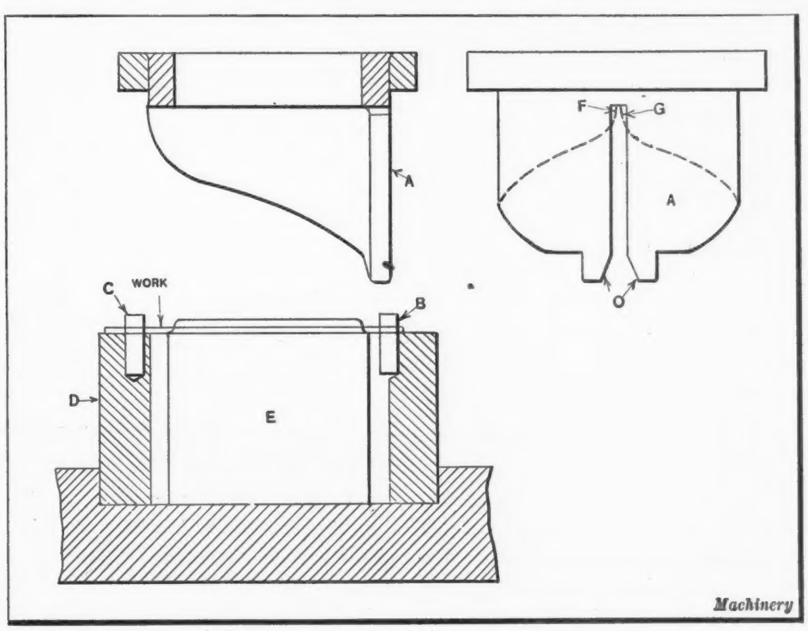


Fig. 6. Design of the Punch Press Tools used in forming the Large Ring

The surface G is nearly square with the inside of the punch, and this construction provides for shaping the wire as desired where the straight section joins the ring. In this operation, the wire is also squeezed a slight amount at the bottom of the stroke to set it. Punch A and ring D are made from seamless steel tubing, and member E from machine steel, these three parts being pack-hardened. In making the dies illustrated in Figs. 3, 4 and 6, it was impossible to try them out before hardening, because the wire would sink into the edges of the die parts and be sheared off.

In the final punch press operation, the sharp end of the wire is curved back toward the ring, as shown at E, Fig. 1. This is accomplished by means of the die illustrated in Fig. 5, which functions similarly to the two preceding dies. No trouble was experienced in making this punch so that it would curve the wire, because the radius of the bend is comparatively small, and the bend extends only 180 degrees. The punch was simply cut at an angle in a milling machine. The work is located on the die-block by means of guide plates on each side of the die, the ring being held flat against the one at the left.

A decorated metal plaque is finally forced on the ring of the wire, as shown at F, Fig. 1. This bill file is used for advertising purposes, and is quite a novelty, as the hook can be brought at right angles to the plaque by giving the wire a twist by hand. Including three operations on the plaque, 11,000 of these files have been produced by three girls in 6½ eight-hour days with a waste of only about 3 per cent.

* * *

F. B. Foley, metallurgist of the Department of the Interior, attached to the Mississippi Valley experiment station of the Bureau of Mines, is making a study of the special adaptability of the steels used in the manufacture of oil well drilling equipment.

BURNISHING AUTOMOBILE CYLINDERS

Although the majority of automobile cylinder bores are finished by grinding or reaming, manufacturers who employ the burnishing or rolling method claim that this practice results in a higher class of finish than is obtained by the other methods, and that the operation costs much less. Microscopic examination of a section through the wall of a burnished cylinder shows a narrow black ring of metal surrounding the bore in front of lighter metal, which indicates that the wall of the cylinder has been compressed in the burnishing process.

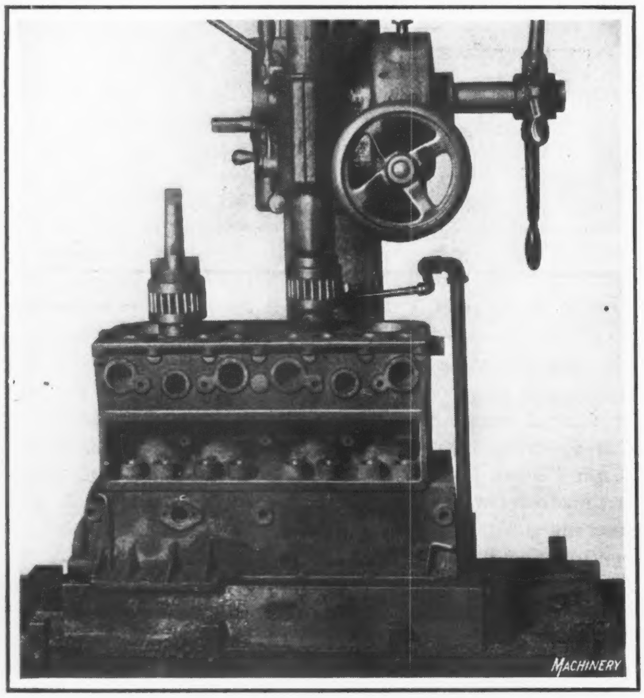


Fig. 1. Finishing the Cylinder Bores of an Automobile Engine by the Use of a Rotating Tool having Twenty-one Rollers

At the plant of the Earl Motors Mfg. Co., Jackson, Mich., the bores of a cylinder block coming from the burnishing machine are as smooth and as highly polished as the cylinder bores of cars that have been run from 2000 to 3000 miles. The hard compressed surface obviates wear of the piston-ring and the cylinder wall when the automobile is first put into use, and it is said that on a car examined after 5000 miles of use none of the cylinder bores was worn more than 0.0005 inch over size. The burnishing operations consists of passing a rotating tool once up and down the bore. With the tool running at about 100 revolutions per minute, only about fifteen seconds is required to burnish each bore to the proper diameter within 0.00075 inch. The error in taper per foot also is never more than 0.00075 inch.

Sectional views of the tool used in the burnishing process are shown in Fig. 2, from which it will be seen that it consists essentially of a holder in which are mounted twenty-one hardened rollers *A* that are free to rotate independently of other members of the unit when the tool is fed into the cylinder bore as shown in Fig. 1. The diameter of the tool, measured across any two opposite rollers, is the same as the diameter to which the cylinder bore is to be finished, or from 3.4375 to 3.4385 inches. The practice is to rough-bore and ream the cylinder bores to from 3.4355 to 3.4365 inches, allowing from 0.001 to 0.0015 inch of metal to be compressed all around the wall of the bore. If more than 0.002 inch of metal is compressed, the cylinder wall expands and becomes out of round when it contracts again after the operation. Burnishing is the last operation performed on the cylinder blocks, and so any distortion that may result from machining is corrected by it.

Both ends of the roller are tapered 0.005 inch on the diameter to facilitate their entry into the bore, and the rollers are inclined from the vertical, at an angle of 2 degrees 23 minutes, as indicated by the dotted lines at *B*, Fig. 2. This inclination of the rollers causes the tool to feed itself either in or out of a cylinder bore, depending upon the direction in which the spindle rotates. The greater the angle of inclination, the faster the rate at which the tool feeds itself. Part *C* of the tool has a Morse taper shank which fits the spindle socket of a Weigel high-speed drilling machine, equipped with a tapping attachment that provides for reversing the direction of spindle rotation. The tool is fed by hand on the down stroke, but the rollers alone are relied upon to feed the tool upward. If the tool were permitted to feed itself on the down stroke, the tendency would be to lift the cylinder block which rests unclamped on the base of the machine, and so the best results are obtained by using the hand feed. By leaving the cylinder block unclamped, it is given sufficient float to permit the tool to follow each bore as it is produced by the preceding reaming operation.

Plenty of lubricant, consisting of graphite and oil, is used in the operation in order to reduce the wear of parts to a minimum. When oil alone is used, the rollers expand and produce over-size bores. Practically all wear is taken by the contacting surfaces of the rollers and spacer ring *D*, as only the flat ends of the rollers bear against plates *E*, the holes in these plates being counterbored somewhat larger in diameter than the roller ends. This allowance is sufficient to permit the inclination of the rollers, as previously mentioned, and it also enables the rollers to follow the bore.

Wear of the spacing ring and rollers is comparatively light. However, when the tool is worn to such an extent that it no longer produces bores within the specified tolerance, the condition is remedied by simply providing a spacer ring *D* of sufficient diameter to expand the rollers again to the proper diameter. It is possible to roll about 400 cylinder blocks (1600 bores) before it is necessary to replace a ring, the wear naturally depending upon the amount of stock compressed. When the rollers have been worn to such an extent that the substitution of a spacer ring no longer remedies the condition, new rollers and a new spacer ring are provided. All parts with the exception of lock-nuts *F* and the washer are hardened and ground. The crankshaft main bearings in the cylinder block and the bearings of all connecting-rods are also burnished at the plant referred to, so that when an automobile is ready to leave the plant all the running parts of the engine are in the same condition as those of a car that has been driven about 3000 miles.

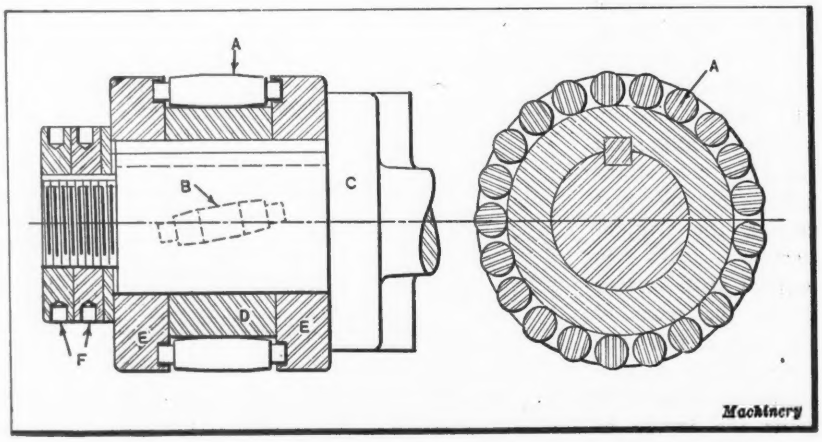


Fig. 2. Sectional Views illustrating the Construction of the Burnishing Tool

Grinding Fixture for Universal Joint Cage

By JOHN A. HONEGGER

THE final machining operation performed on the universal joint cage shown in the lower right-hand corner of the accompanying illustration is that of grinding the faces *A* of the two slots that are located at right angles to each other. This universal joint cage is attached to the driving shaft of an automobile. The eight faces *A* of the two slots must be accurately ground so that the slots will be equally spaced about the center of the cage and also parallel with the axis of the cage.

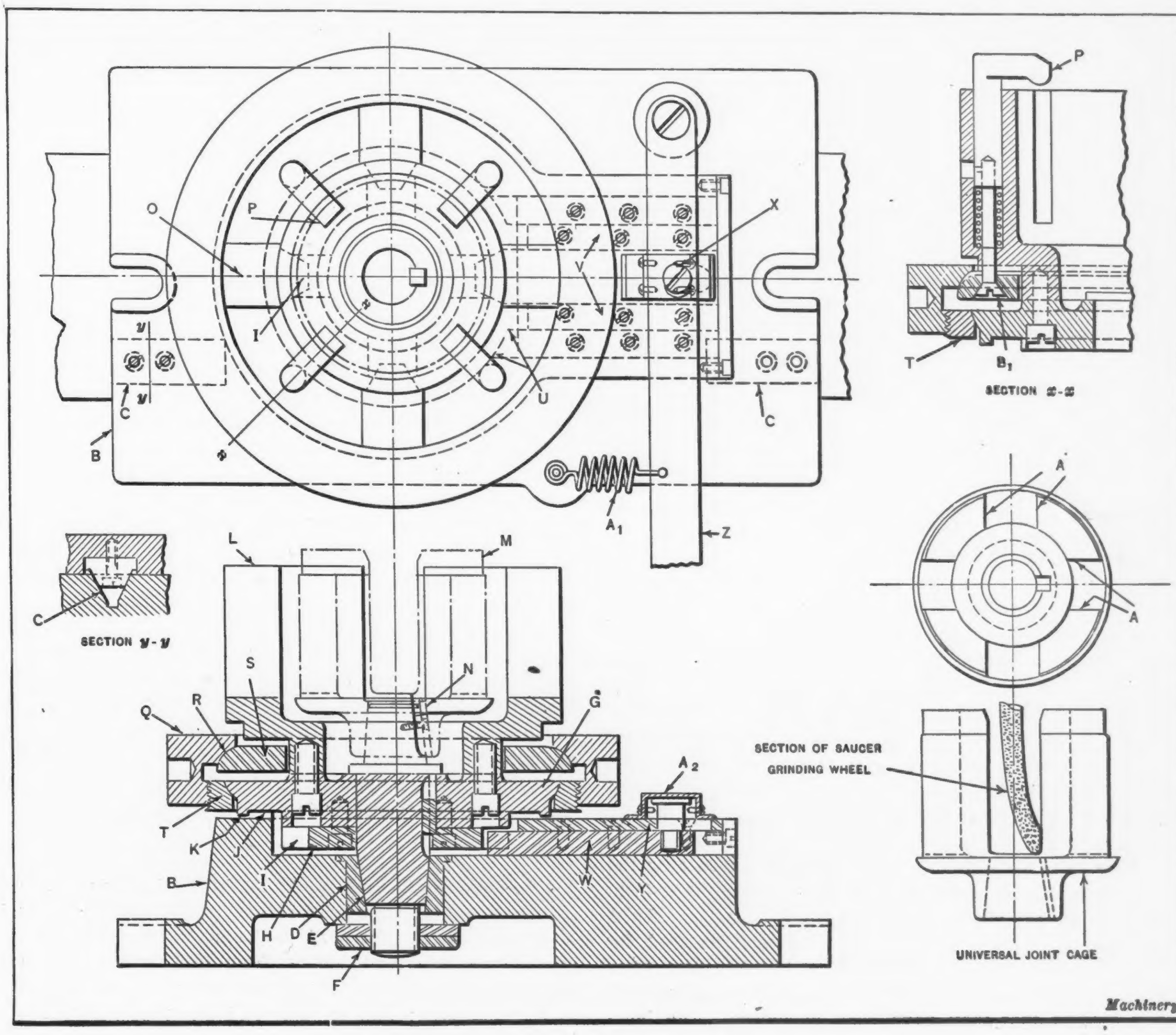
Construction of Fixture

The fixture consists of a cast-iron base *B*, slotted on the under side to receive the tapered keys *C* which locate the fixture on the grinder table. A circular recess is machined in the upper side of base *B*, in the center of which a hole is bored to receive the hardened and ground bushing *D*. The hardened and ground combination locating plug and indexing spindle *E* is fitted into this bushing and held in position by the clamping nuts *F*.

To spindle *E* is keyed the faceplate *G* and the hardened and ground indexing ring *H*. This indexing ring has four tapered notches *I*, cut in the edge or periphery. Ring *H* is fastened to faceplate *G* as shown. It will be noted that the faceplate has an outboard bearing *J*. The projecting ring *K* clears base *B* so that the tapered spindle *E* is permitted to centralize the faceplate.

A cast-iron cage *L*, similar in outline to the part to be ground is fastened to the upper face of plate *G*, and the universal joint cage (shown by dot-and-dash lines *M*) is located inside cage *L*. The operator simply drops the piece of work over the upper end of the tapered plug *E* and turns it around until the slot or keyway is in line with the key *N* in the plug. The four slots *O* are milled to a width $\frac{1}{4}$ inch ($\frac{1}{8}$ inch on a side) greater than that of the slots in the piece to be ground. Ample clearance is thus provided for the saucer-shaped wheel employed in the grinding operation.

It is essential that equal pressure be applied by the four lugs *P* in clamping the work in the fixture. Any unequal pressure would cause the work to be forced out of alignment with the spindle. The construction of the lugs *P*, as shown in the section x–x provides for the application of equal pressure on the work at each of the four bearing points. Holes are bored midway between the four slots in cage *L* to receive the four hook-shaped bolts or lugs *P* and the springs. The ring *Q* is accurately bored, recessed, and threaded. The radius at *R* is formed to fit that of the clamping ring *S*. The



Indexing Fixture used in grinding Universal Joint Cage

radius of ring S is made slightly smaller than the radius R, and the four holes for the clamping screws B_1 (shown in section x–x) are drilled and countersunk in ring S.

The inner surface of ring T and the periphery of the faceplate G are fitted together similarly to parts S and Q. Ring S is relieved in such a manner that it bears only on three points in order to eliminate friction as far as possible between the bearing surfaces. The ring T is provided with a stop-pin which is located in an elongated hole (not shown) and which allows ring T to rock vertically but keeps it from turning during the clamping operation.

Assembling the Fixture

The parts of this fixture were assembled in the following manner: The four hook-shaped bolts and the springs were placed in their respective holes. Clamping rings Q and S were then placed in position on the under side of the cage, so that the holes lined up with those in the cage. The clamping screws B_1, were next inserted. By pressing down on bolts P, the threaded ends of screws B_1 were made to engage the tapped hole in the lower ends of the bolts. Screws B_1 were then tightened with a screwdriver, after the rocker ring T was placed in position under the faceplate. The cast-iron cage, together with the assembly rings, was next bolted to the faceplate, and the outer ring screwed to the rocker ring. It will be noted that there is a clearance between the base of each ring and the part that surrounds it. This construction is therefore, in one sense of the word, of the floating type.

Operation of Fixture

When a piece of work is to be inserted in the fixture the hook-shaped bolts P are swung outward, and the work is dropped into place on the locating pin E. The hook-bolts are then swung back into the position shown in the illustration. Next, the ring Q is tightened until the four bolts bear evenly on the work, a pin or rod being inserted in one of the holes in the ring to provide a means of turning or tightening it. The floating action of the clamping members of the fixture permit any slight variation in the work to be compensated for, so that an even clamping pressure is applied at all four points. At the points U a horizontal slot merges into or enters the circular depression in the base of the fixture. The bottom of this slot is on the same level as the circular depression, and forms the lower bearing surface of a pocket in which the indexing plunger W slides.

On the sides of the indexing plunger pocket are two hardened and ground steel side-thrust plates V which are fastened in place by suitable screws. The plunger or slide W is guided between these thrust plates. The plunger is hardened and ground to a sliding fit on the sides, top, and bottom. On the rear end of the plunger there is a hole which is tapped to receive the lever stud X. This stud passes through an elongated hole in the cover plate Y. This plate covers the full width of the groove in which the plunger slides, and projects under the faceplate, thus preventing particles of abrasive from finding their way into the indexing mechanism. There is also a cover plate at the rear end of the indexing pin slot, so the pocket is completely enclosed.

The stud X also passed through an elongated hole in lever Z. This hole is counterbored so that the head of the stud is flush with the top of the lever. The lever is pivoted at its outer end, as shown, and is normally maintained in a closed position by spring A_1.

In order to prevent any dust or particles of abrasive from working into the index mechanism through the elongated hole in plate Y, the cover plate A_2 is placed over the lever. This cover is so constructed that when lever Z is in either position, the elongated hole is completely covered. A saucer type of wheel, as previously mentioned, is used for the grinding operation. A roughing cut is taken first, after which the clamps are loosened, in order to relieve the work of any strains that may have been developed. The bolts are then retightened and a light finishing cut taken.

The transverse adjustment of the grinding machine table is employed to adjust the work for the roughing and for the finishing cuts. The longitudinal traverse feed of the table is employed after the table is properly set for the required depth of cut. The fixture with the work in place thus travels back and forth under the grinding wheel. When one of the faces of a slot has been rough-ground, the fixture is indexed into position for a roughing cut on the next face. The work is indexed in the same manner when taking the finishing cut.

* * *

AMERICAN MUSEUM OF SAFETY

A new and broader field of usefulness lies before the American Museum of Safety. Founded in 1906 and the oldest organization of its kind here, its support has come in the past from private sources. It is now to receive the support of the state, and its exhibits are to be housed in a state building in a manner worthy of the great movement it represents. An annex to the Department of Labor building of the state of New York is now under construction at 120 E. 29th St., New York City, and in this building will be placed both the permanent and the temporary exhibits. A progressive policy will be inaugurated under the management of the new director, Albert A. Hopkins.

In addition to the permanent collection of safety exhibits, which itself will be changed from time to time to keep pace with the new methods and devices as they appear in the various industries, there will be set apart space for temporary exhibits which will be changed from month to month. The Museum will thus offer a permanent exhibition of great educational value to employers and employes alike, and also a changing exhibition of special interest to those engaged in particular industries. The exhibits for the first three months in this new department will cover, in order, laundry machinery, the printing industry, and the needle trades. Under the able guidance of the new director, and with the substantial support of the state and the active cooperation of the manufacturers of the city and state, the American Museum of Safety promises to fill a larger place in the field of safety than ever before.

* * *

MACHINERY TRADE WITH JAPAN

A recent summary of the machinery trade with Japan during the last ten years, published by the Industrial Machinery Division of the Department of Commerce, shows clearly how the United States has acquired a constantly increasing share of the Japanese machinery market. In 1913 Great Britain supplied the larger part of the power plant machinery, pumps, cranes, metal- and wood-working machinery, paper mill machinery, textile machinery, and hydraulic presses imported into Japan, while America led only in knitting machinery, gas compressors, and blowing machines. In 1920 the situation had altered so that of the total amount of machinery imported into Japan, Great Britain supplied only 20.6 per cent, while the United States supplied 51.4 per cent; and Great Britain led only in steam, gas, oil, and hot air engines, textile machinery, and fuel economizers, while the United States led in metal- and wood-working machinery, steam and water turbines, boilers, pumping machinery, knitting machinery, paper-making machinery, gas compressors, hydraulic presses, blowing machines, and pneumatic tools.

* * *

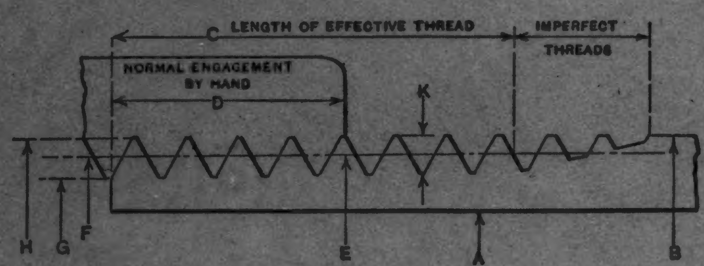
A cold-rolled machine steel containing about 0.50 per cent carbon is sometimes used for such profile gages as may be easily ground after hardening. This steel may have a composition as follows: Carbon, from 0.40 to 0.55 per cent; manganese, from 0.55 to 0.80 per cent; silicon, from 0.15 to 0.20 per cent; and sulphur and phosphorus, from 0.035 to 0.05 per cent.

MACHINERY'S DATA SHEETS Nos. 19 and 20

CUT OUT ON THIS LINE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

STANDARD PIPE THREAD



For all dimensions see corresponding reference letters in table.

Angle between sides of thread is 60 degrees when measured in the axial plane and a line bisecting this angle is perpendicular to the axis of the pipe.

The thread depth is 0.8 × pitch of thread and the crest and root are truncated an amount equal to 0.033 × pitch.

All dimensions in inches.

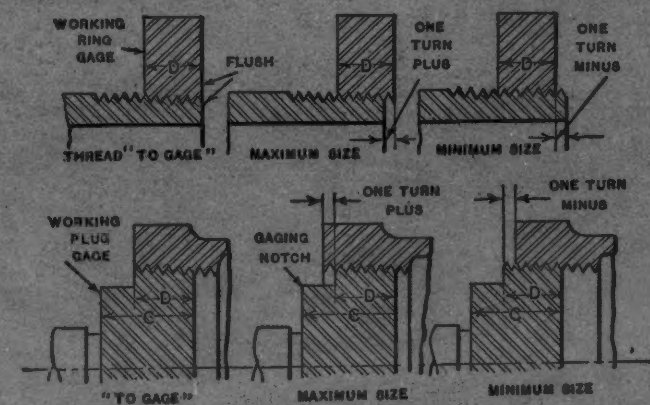
Diameter of Pipe: Nominal Inside	Diameter of Pipe: Actual Inside	Diameter of Pipe: Actual Outside	No. of Threads per Inch	Length of Effective Thread	Length of Normal Engagement by Hand	Pitch Diameter at Gaging Notch	Pitch Diameter at Small End of Thread	Root Diameter at Small End of Thread
	A	B		C	D	E	F	G
1/8	0.269	0.405	27	0.264	0.18	0.3748	0.3635	0.334
1/4	0.364	0.540	18	0.402	0.20	0.4899	0.4774	0.433
3/8	0.493	0.675	18	0.408	0.24	0.6270	0.6120	0.568
1/2	0.622	0.840	14	0.534	0.32	0.7784	0.7584	0.701
3/4	0.824	1.050	14	0.548	0.34	0.9889	0.9677	0.911
1	1.049	1.315	11 1/2	0.683	0.40	1.2386	1.2136	1.144
1 1/4	1.380	1.660	11 1/2	0.707	0.42	1.5834	1.5571	1.488
1 1/2	1.610	1.900	11 1/2	0.724	0.42	1.8223	1.7961	1.727
2	2.067	2.375	11 1/2	0.757	0.44	2.2963	2.2690	2.199
2 1/2	2.469	2.875	8	1.138	0.68	2.7622	2.7195	2.620
3	3.068	3.500	8	1.200	0.77	3.3885	3.3406	3.241
3 1/2	3.548	4.000	8	1.250	0.82	3.8888	3.8375	3.738
4	4.026	4.500	8	1.300	0.84	4.3871	4.3344	4.234
4 1/2	4.506	5.000	8	1.350	0.88	4.8859	4.8313	4.731
5	5.047	5.563	8	1.406	0.94	5.4493	5.3907	5.291
6	6.065	6.625	8	1.513	0.96	6.5060	6.4461	6.346
7	7.023	7.625	8	1.613	1.00	7.5023	7.4398	7.340
8	7.981	8.625	8	1.713	1.06	8.5000	8.4336	8.334
9	8.941	9.625	8	1.813	1.13	9.4980	9.4273	9.327
10	10.020	10.750	8	1.925	1.21	10.6209	10.5453	10.445
11	11.000	11.750	8	2.025	1.29	11.6194	11.5391	11.439
12	12.000	12.750	8	2.125	1.36	12.6178	12.5328	12.433

MACHINERY'S Data Sheet No. 19, New Series, October 1923

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

STANDARD PIPE THREAD—CONTINUED



For dimensions *C* and *D*, see corresponding reference letters in section of table on opposite page.

Nominal Inside Diameter	Outside Diam. at Small End of Thread	Reamer Diam. at Large End of Reamed Hole	Depth of Thread	Reference Gages: Minimum Pitch Diam., Small End	Reference Gages: Maximum Pitch Diam., Small End	New Working Gages: Minimum Pitch Diam., Small End	New Working Gages: Maximum Pitch Diam., Small End	New Working Gages: Equivalent Longitudinal Variation
	H		K					
1/8	0.393	0.345	0.0296	0.3633	0.3637	0.3631	0.3639	0.0064
1/4	0.522	0.445	0.0444	0.4772	0.4776	0.4770	0.4778	0.0070
3/8	0.656	0.583	0.0444	0.6118	0.6123	0.6115	0.6125	0.0077
1/2	0.816	0.721	0.0571	0.7582	0.7587	0.7579	0.7590	0.0083
3/4	1.025	0.932	0.0571	0.9674	0.9680	0.9671	0.9682	0.0090
1	1.283	1.169	0.0696	1.2133	1.2139	1.2130	1.2142	0.0096
1 1/4	1.627	1.514	0.0696	1.5568	1.5575	1.5565	1.5578	0.0102
1 1/2	1.866	1.753	0.0696	1.7958	1.7964	1.7954	1.7968	0.0109
2	2.339	2.227	0.0696	2.2687	2.2694	2.2683	2.2697	0.0115
2 1/2	2.820	2.662	0.1000	2.7192	2.7200	2.7188	2.7203	0.0122
3	3.441	3.289	0.1000	3.3403	3.3410	3.3399	3.3414	0.0122
3 1/2	3.938	3.789	0.1000	3.8371	3.8379	3.8367	3.8383	0.0131
4	4.434	4.287	0.1000	4.3340	4.3348	4.3335	4.3352	0.0138
4 1/2	4.931	4.786	0.1000	4.8308	4.8317	4.8304	4.8322	0.0144
5	5.491	5.349	0.1000	5.3903	5.3912	5.3898	5.3917	0.0150
6	6.546	6.406	0.1000	6.4456	6.4466	6.4451	6.4471	0.0163
7	7.540	7.402	0.1000	7.4393	7.4404	7.4387	7.4409	0.0176
8	8.534	8.400	0.1000	8.4330	8.4342	8.4324	8.4348	0.0189
9	9.527	9.398	0.1000	9.4267	9.4280	9.4261	9.4286	0.0202
10	10.645	10.521	0.1000	10.5447	10.5460	10.5440	10.5466	0.0211
11	11.639	11.519	0.1000	....	....	....	....	....
12	12.633	12.518	0.1000	12.5321	12.5336	12.5313	12.5343	0.0237

MACHINERY'S Data Sheet No. 20, New Series, October 1923

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, September 15

REPORTS from the various centers are conflicting, and while there are cases of firms in the engineering industry working night and day, there are several centers in which pessimistic views prevail. At the same time a large number of manufacturers are not finding trade worse at the present time than it has been since the beginning of the year.

The Machine Tool Industry

In the machine tool industry, there has been little change during the past month. Trade everywhere, however, is very patchy. Nevertheless, there is a strong feeling among machine tool makers, especially in the Manchester area, that the period after the autumn will see more steady progress. Despite the unpromising conditions in the shipyards, many inquiries for machine tools continue to be received from this source, as well as from the heavy electrical trades who have in addition placed a few substantial orders.

In the Birmingham area, machine tool works are operating roughly at about 40 per cent of capacity. Inquiry is good and is not confined to one or two types, while designing departments are active on special machines. One well-known Birmingham firm that has been developing tools for the automobile industry has enough work on hand to last until the end of the year. In this area there is an improving demand for turret lathes, and both home and overseas business, in very encouraging quantities, is coming in for these tools. Power presses in the smaller sizes are in fair demand, and the demand for milling and drilling machines is improving, while there has been some inquiry for single- and multiple-spindle automatic machines with capacity for bars up to 1¾ inches in diameter.

In the Yorkshire area, William Asquith, Ltd., has a large variety of radial and non-radial drilling machines going through the works, and a new design of twist drill grinder is being produced in quantity by this firm. In the vicinity of Glasgow, there is said to be a large volume of inquiry from abroad, but few orders materialize; heavy transport charges are still high barriers to overseas trade. In this area, observation has shown that during a period of twelve months only about 25 per cent of overseas inquiries were carried by the originator to the buying point. Of this 25 per cent, Great Britain received approximately three-fifths, and America and Germany one-fifth each.

The demand for small tools is improving. It is evident that dealers' stocks are getting very low, and orders for taps, twist drills, and milling cutters are being placed on a much more generous scale; as small tool manufacturers have been running at maximum capacity for some time now, the prospects are good.

Conditions in the General Engineering Field

Heavy electrical equipment manufacturers continue to be busy, but orders are not coming in so freely. The installation of Diesel type engines in boats being built on the Mersey and on the East Coast has brought a certain amount of work to engine builders in the Manchester area. In Scotland locomotive works are a little busier with additional orders for the Colonies and South America; local builders of rolling stock have also benefited.

In the Yorkshire area, heavy engineering work is at a standstill. In Sheffield, considerable work is assured in the execution of a large order in the hands of Davy Bros., Ltd., for a plate-rolling plant to be installed at Durham. It will constitute the largest plant of its type in the country. Electrical engineers are moderately employed. In other branches, engineering work is very much depressed.

In Leeds, some satisfaction is to be gained from the contract for fifty steel railway cars for the New South Wales Railways; the contract, which is in the hands of the Leeds Forge Co., Ltd., will occupy their Newlay works for several months. An English company has obtained the contract for the construction of a railway in Spain; contracts for the necessary locomotives and rolling stock will also be placed in England. Cammell Laird & Co., Ltd., have received an order for seventy-seven motor and trailer cars for the Great Indian Peninsular Railway.

The strength of the core of engineering industry in this country is shown in the whole-heartedness with which important exhibitions are being supported. At the present writing, Olympia is the scene of a shipping, engineering, and machinery exhibition, and although the floor area of the building has been increased by 40 per cent, the exhibition is undoubtedly a success and the hall is comfortably filled with exhibitors that are representative of all branches of the engineering industry. At the British Empire Exhibition to be held next year in Wembley, a huge building six or seven times the size of Olympia is to be devoted to the engineering industry. Already over 80 per cent of the available space has been reserved.

The Shipbuilding Industry

On the Clyde, where not one cargo boat has been launched since the end of June, it is feared that several firms will have to close down unless there is an early improvement in the industrial situation. If this occurs, these yards are not likely to be reopened until the question of the boilermakers' lock-out has been settled. In all shipbuilding centers, the building of new tonnage continues at a very low level. On the Mersey side there is general talk of an adoption of short time, and some big repair yards in this center are very short of work. The shipyards in August turned out nine vessels of a total tonnage of but 1855; the total output for the last eight months has been 137,828.

Overseas Trade in Machine Tools

During July the export of machine tools fell from 1050 tons at a value of £110,769 (the figure for June) to 790 tons at a value of £81,170. The exported tonnage is the lowest recorded for the last twelve months. Imports also fell in July. The value reached only £39,367 for a tonnage of 291, as against £53,403 for 406 tons in the previous month. The value per ton of exports was £103 and of imports £135—figures that have remained more or less regular for the last four months. Of the total value of £81,170 for machine tool exports in July, over £27,400 was represented by lathes. Lathes amounted to about one-third the value of imported machine tools.

On the whole, employment in the engineering industry showed a slight improvement during July. In the Glasgow area the percentage of shipyard unemployed is now 42 per cent, and 29 per cent of engine shop men are without work.

Progress in Grinding Wheel Manufacture

By P. H. WALKER, The Carborundum Co., Niagara Falls, N. Y.

DURING the last twenty years, grinding practice has passed through at least two major stages. At first, grinding was used mainly as a roughing or snagging operation performed on wheels mounted on floor stands, lathes, or other simple machines; this stage was later developed until grinding was employed by skilled mechanics for precision work. In the second stage, grinding began to be used as a commercial production method. With the aid of a universal grinding machine and a fair selection of wheels of different grits and grades, an expert grinding machine operator could produce work of high accuracy. Specialization and standardization subsequently extended to the development of grinding machines and grinding wheels, the same as in other fields, as quantity production at reduced costs required the development of new machines and wheels to produce work of great accuracy.

From a skilled art, grinding practice then developed into an engineering science, with trained abrasive engineers, grinding efficiency experts, and specialized service departments, maintained both by grinding machine builders and grinding wheel manufacturers. Just as "Necessity is the mother of invention," so we may say that "Competition is the father of invention"—competition between lathes and cylindrical grinders, between milling machines and surface grinders of both the side and vertical type, and between ordinary cylindrical grinders and centerless grinders. Out of all this competition has come the great improvement in grinding machines that characterizes present-day developments in this field.

Developments in Grinding Wheels

All the improvements, however, have not been in grinding machines. The manufacturers of wheels have also had to keep pace with the general progress, and their problems have been many. Among these have been the quantity production of a uniform standardized product and the development of new bonding materials and new abrasives to meet new conditions. To solve these problems, it has been necessary to introduce a scientific control of every part of the process. In this case, as in many of the ceramic industries, important details in the process had depended upon the judgment of individuals. However, skill and judgment can never produce as uniform results as scientifically developed methods, and recently there have been marked advances in the control of the processes by which grinding wheels are made, so that uniform quality, and the possibility of exact duplication of past performances, are made possible. In connection with this work, it is of importance to both wheel makers and wheel users that exact and complete cost and production records be maintained on all important grinding operations.

Records of Grinding Wheel Performance

The progressive grinding wheel manufacturer welcomes comparative records kept by the users, as any change either in shop conditions, in the material to be ground, or in the quality of the wheels can thus be detected and the difficulty overcome. There are so many slight variations possible in the structure and grade of wheels intended even for a single operation, that it is necessary to have a definite understanding of what the standard should be in judging the performance. The life of a wheel alone, or the number of pieces ground per wheel alone, does not present a satisfactory means for judging the total performance. This might be illustrated by tabulating the average results of several groups of wheels of various makes on a rough-grinding operation in a large foundry. The figures give the averages for at least five wheels of each kind.

No. of Test	Grit of Wheel	Grade of Wheel	Pieces Ground per Wheel	Stock Removed per Wheel, Pounds	Life of Wheel, Hours	Metal Removed per Hour, Pounds
1	14	P	20.3	54.0	12.25	4.41
2	14	P	20.3	43.3	9.9	4.37
3	16	Q	13.0	31.5	6.7	4.72
4	16	Q	5.0	23.0	4.3	5.35
5	16	Q	14.0	38.0	7.9	4.75

The differences between wheels Nos. 3, 4, and 5 are differences in bond or structure; nevertheless these wheels indicate the same grade when tested. It is apparent that the choosing of the proper wheel on the basis of cutting rate per hour alone would lead to an entirely different result from that arrived at if the wheel were selected on the basis of hours of life, or the total amount of stock removed by the wheel. It is therefore necessary that all these factors be studied, and a definite understanding reached as to what constitutes a standard of production so that fair comparisons can be made.

The table further indicates the great difference in grinding action that may be present in wheels of apparently the same grade, as illustrated in wheels Nos. 3, 4, and 5. This also shows the danger of using wheels made by different manufacturers indiscriminately, even though they appear to be the same according to a comparative grade scale.

New Developments in Vitrified Wheels

Some of the new advances made in vitrified grinding wheels are of considerable interest. An entirely new wheel has been developed by the Carborundum Co. for use on vertical surface grinders of the Blanchard and the Pratt & Whitney types. The production of these wheels has always been a difficult problem on account of the high losses met with in manufacture, and because of the nature of the grinding operation, which demands an open fast-cutting wheel that will cut freely without excessive heat and will not wear unduly even at low operating and work speeds. The new wheels that meet these requirements are known as "LL" wheels. New methods of molding and burning have been introduced, and the product represents the greatest single advance in this particular line of the company's wheels. Many other applications in the cylindrical grinding field have been found for this type of wheel since it was introduced.

Radical improvements have also been made in wheels for heavy snagging operations in foundries. These wheels are very open and tough-bonded, and have a coarse grit, they are characterized by high production rates per hour accompanied by low wheel wear. In order to obtain these characteristics, it was necessary to prepare a combination of clays which in the vitrified state would have a very high tensile strength, a high shrinkage to leave the maximum voids between the abrasive grains, and a uniform fluxing action on the abrasive itself to insure the retention of the individual grain in the periphery of the wheel until it had done a maximum amount of cutting.

During the two years when these snagging wheels were being developed, a manufacturer of heavy railroad castings made a series of tests in his foundry. These tests were made at intervals of from three to six months and included wheels of seven makers. The cost figures included wheel cost, labor cost, and overhead, and the results obtained strikingly illustrate the results that have been accomplished by the concentration that has taken place on the production of the most efficient wheel for a particular kind of grinding. In the five series of tests made on aloxite wheels the results were as follows:

Tests	Castings per Wheel	Grinding Costs per Casting
First series	44	$1.63
Second series	85	1.21
Third series	105	1.30
Fourth series	127	1.03
Fifth series	157	0.81

It will be seen that the number of pieces per wheel was nearly quadrupled, while the cost was cut in half. The third series, compared with the second series, shows the effect of a harder wheel in which the freedom of cut has been sacrificed, thus increasing labor costs faster than wheel costs have been reduced.

Improvements in Abrasives

Wheel manufacturers have also made extensive experiments with a view to improving the quality and structure of the abrasive used. The wheel user will readily recognize this when he considers the many different abrasives that are available, as for example: "regular" alundum, "66" alundum, "38" alundum, "regular" aloxite, "AA" aloxite, "77" carbolite, etc. These represent different chemical composition and physical structure, and hence will produce different action in the grinding wheel when used for different classes of metal.

For example, in the grinding of hardened high-speed steel and stellite, the main object is to produce as little heat as possible, to prevent warping and checking. A wheel of a regular aluminous abrasive, no matter how low the bond content or how brittle the bond, will not do this work efficiently. The wheel may be so soft with respect to its bond as to shed its grains under the pressure of the cut, as a pinwheel sheds sparks, and still its grinding efficiency will be low because the grains dull rapidly in penetrating the hardened steel. It was for this purpose that AA aloxite was developed, which has a lower tensile and crushing strength than regular aloxite and which has a long slender crystalline structure. In grinding, this new abrasive splinters off and thus constantly presents sharp cutting points. The wheel requires little dressing, and the wheel wear is reduced because the grains fracture instead of being torn bodily from the face of the wheel.

Improvements have also been made in rubber-bonded wheels, those now on the market so far surpassing former wheels as to set entirely new standards of production. The use of phenol condensation products in wheels of the elastic-bonded type has also revolutionized the methods of making cut-off wheels, raceway-grinding wheels, and many other types for special purposes.

Developments in Polishing Grain

Equal advances have been made in increasing the efficiency of polishing grain, as a result of a close study of the requirements in different industries. The principal qualities desired in polishing grain are toughness and sharpness, and in the case of grain for polishing wheels, a strong glue adhesive quality. These qualities are controlled by the chemical composition and crystallization, and by the crushing and grinding methods, as well as by the furnace treatment.

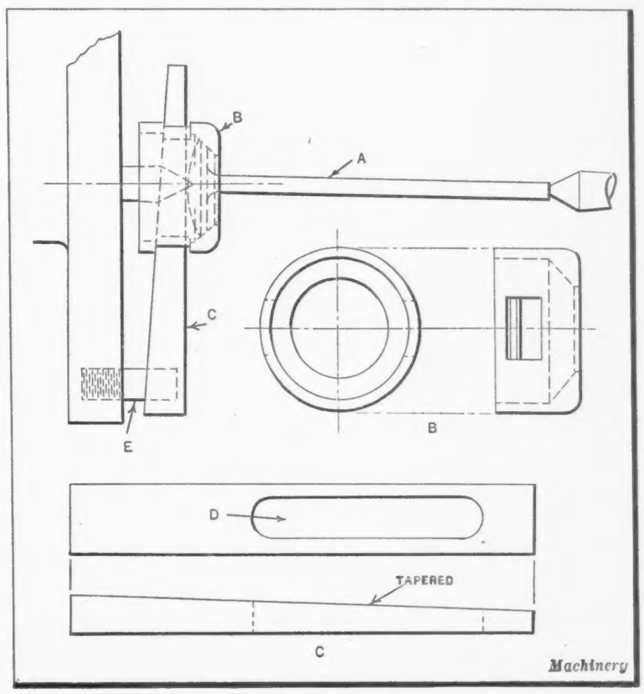
The progress in the abrasive field includes many other improvements that could be enumerated, but those mentioned will indicate to the men in the mechanical field the developments that are taking place in the production of abrasives and grinding wheels, which are second to none in the machine-building field. The frank opinions and the cooperation of the user, together with his helpful suggestions, lead the abrasive manufacturer constantly to develop new methods and to attack new problems. This makes it possible to give better service and to meet the new demands in the constantly expanding field for the application of grinding wheels and abrasives.

* * *

SPECIAL FIXTURE FOR TURNING VALVE STEMS

By G. A. LUERS

In a certain shop specializing in engine repair work, a large number of over-size valves are required to have the stems turned down so that they will be a snug fit in the valve guides. The turning of the heads of the valves to meet the requirements is a simple job, as a regular lathe



Method of holding Valve while turning Stem

dog can be clamped to the valve stem. The usual means for holding lathe work, however, cannot be used in turning the stem *A*. For this work excellent results are now being obtained by using a holder consisting of a cylindrical body *B*, with a beveled seat against which the valve face is placed, and a tapered key *C* which wedges against the head of the valve, as indicated in the upper view of the illustration. The center of the key has an opening cut through it at *D* so that the lathe center can pass through it and make contact with the center in the head of the valve stem. One end of the key *C* is made of sufficient length to engage the stud *E* on the faceplate of the lathe. The fixture described can be used for holding valves of different sizes, and can be readily applied or detached from the valve.

* * *

In order to encourage good arrangements of exhibits at the National Exposition of Power and Mechanical Engineering to be held at Grand Central Palace, New York City, December 3–8, certificates of merit will be awarded to exhibitors whose exhibits are effectively arranged.

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'THE MASTER TOOLS OF INDUSTRY'

There are few industries in which the individual manufacturer willingly assumes so direct a responsibility for the quality of his product as does the machine tool builder, and therefore few industries in which pride in the product is greater. A machine tool always carries the maker's name; and the maker, even when the sale is made through a dealer, feels that he is responsible directly to the customer. There is no series of middlemen between the manufacturer and the ultimate consumer such as exists in some trades, and this is one reason why the machine tool industry has developed standards of quality that are lacking in some other fields.

Machine tool builders, as a class, have faith in their product. No one who has frequently visited the machine tool plants throughout the country can fail to realize that every manufacturer honestly feels that his line is as good as, if not better than, any similar product selling at about the same price. If a question of doubt ever arises in his mind, he immediately endeavors to add improved features and to develop his machine to the point where he again feels certain that it equals or excels his competitor's. This continuous and expensive effort has brought about a more rapid development in machine tool design than in almost any machinery line, which, with the other factors, has been largely responsible for the present high state of perfection of almost all types of American machine tools.

It is sometimes said that the manufacture of machine tools has not yielded the returns received from other industries requiring less ability, energy and perseverance; but from the point of view of achievement the machine tool industry always has been the foundation of increased production—which means improved living conditions—throughout the civilized world. When Dean Kimball, at the last meeting of the National Machine Tool Builders' Association, called machine tools "The master tools of industry," he gave them a well-deserved title. The pride of product has impelled the machine tool builder to render a service to all industry that is far greater than any recompense which, as a class, machine tool builders have ever received; and that is, surely, the very summit of success.

* * *

MOVIES IN THE INDUSTRIES

Several well-known manufacturers of machine tools and small tools have recently had motion picture films made of mechanical operations for educational and publicity purposes. These pictures are of interest and value in showing the right and wrong way of operating, adjusting and caring for machine tools and other shop equipment. The films are furnished to other manufacturers to be shown at meetings of their foremen and employees, to local engineering societies and clubs, and to technical educational institutions. Many of these pictures have been produced with great care, and are of practical educational value on the subjects dealt with. In one film, for example, the operation of automatic screw machines is comprehensively handled; in another, the proper grinding and care of twist drills, showing the causes of broken drills; and in still another, the many uses of grinding wheels in the industries. A very interesting film of production milling in railroad shops has also been produced; this film shows the use of this educational means in a specific industry, and has doubtless good publicity value.

While such instruction is only supplementary to that obtained by thorough and continuous study, there is much to be said in its favor. Shown in a movie, it holds the attention and creates an interest that will stimulate the ambitious men in the audience to seek further information on the subject. The manufacturer is able by the motion picture route to take a vast number of visitors through his factory. He can show men in distant cities, and even in foreign countries, the equipment and facilities of his plant, the methods in use there, and many practical details in connection with the operation of his machines. The principal objection to the general use of motion pictures for publicity purposes are their great cost and the somewhat elaborate organization necessary to reach different audiences; but large manufacturing concerns may find this means of publicity a valuable adjunct to the more conventional methods for interesting prospective users of their products.

One of the first applications of motion pictures to mechanical operations showed the manufacture of a 9.2-inch high-explosive shell before the National Machine Tool Builders' Association at Cincinnati in October, 1917. The photograpns were made in the works of a shell manufacturer, who had developed unusually efficient methods, by the late Chester L. Lucas of MACHINERY, and the various operations were described by him as the film was shown.

* * *

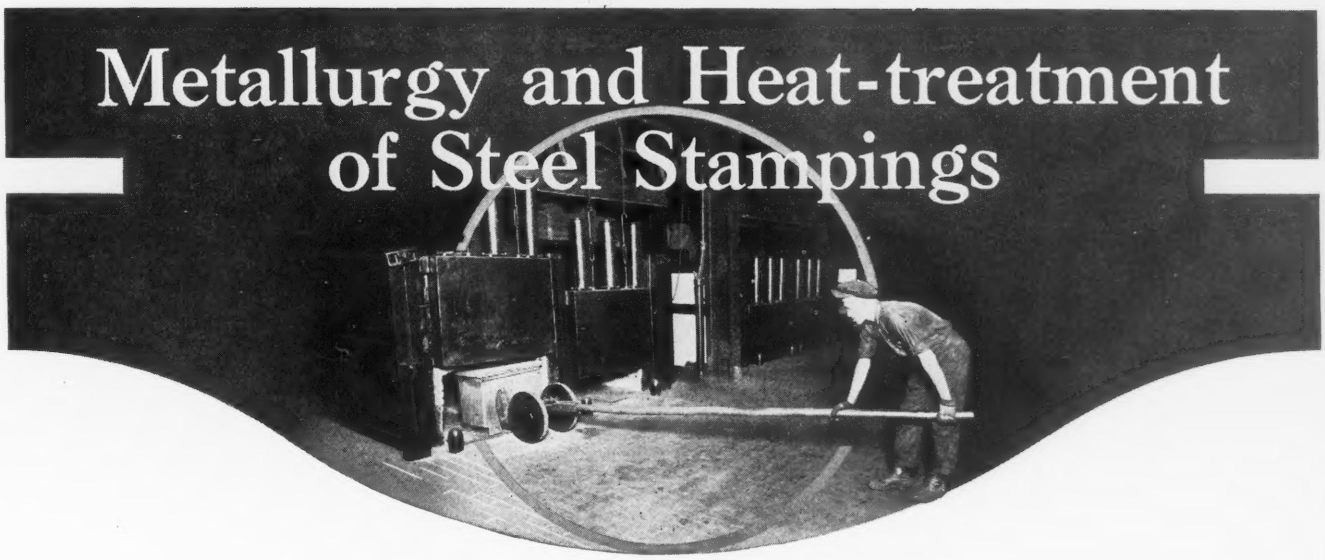
WRITING FOR PUBLICATION

The most important return to the man who writes for a technical journal is not the money he receives, but the mental training incident to the preparation of his articles. It is generally acknowledged that men who can stand up in public and express their thoughts with convincing force have a great advantage over those who lack that ability. It is equally true that men who can express in writing their thoughts, ideas and discoveries on any useful subject, especially those helpful to science or the industries, also have a decided advantage over those not so gifted, although equally well informed. To convey an engineering idea clearly and concisely in writing, clear and concise thinking is necessary; and few attainments are of greater value to a man engaged in engineering pursuits than the ability to analyze in this way the mechanical problems that come before him.

Writing for the technical press also stimulates further study on the part of the writer. If a man really wishes to find out how much he knows about a subject, let him write a treatise on it with the purpose of transferring his knowledge to others. Very often he will find that he knows less about the subject than he thought, and that further investigation is necessary before he can present an accurate, detailed and complete article for publication. Writing for the technical press therefore helps a man to increase his own knowledge on the subject in hand.

Such work also has a legitimate publicity value well worth consideration. No technical man can reach a larger audience than that represented by the readers of an engineering journal. Through that medium more people will learn to know his name and to associate it with valuable information on subjects with which he is familiar—perhaps an authority on. Many men have found careers that would never have opened to them but for the publicity received in connection with informative articles of theirs published by well-known technical journals.

Metallurgy and Heat-treatment of Steel Stampings



By RALPH H. SHERRY, Metallurgical Engineer

THE metallurgy and heat-treatment of steel has received marked attention in recent years, the general principles having been discussed to a considerable extent and much information having been published on these subjects. The knowledge thus made available has been applied successfully to some of the processes involving the handling of steel. However, there are several processes which have not received the attention that their importance would seem to require. Among these is the cold-working and annealing of low-carbon steel. The seeming simplicity of these operations may be responsible for their neglect by the metallurgist and heat-treating specialist.

Annealing Necessary for Cold-worked Steel

The cold-working and annealing processes have been carried on for years and, stated in a general way, are comparatively simple. Cold-working carried on to any considerable degree hardens the steel, and it becomes necessary to soften it by simply raising its temperature to a point at which the hardness is removed before further operations can be performed satisfactorily. Where low-carbon steel is concerned, however, these apparently simple processes are sometimes exceedingly complex. In the first place, the annealing must be carried on with an exact temperature control and with uniformity. In the second place, careful attention to these factors will not necessarily insure uniform results, as low-carbon steel, under certain conditions, may undergo a peculiar change in its structure for which cold-working and annealing, as ordinarily applied, may be responsible. The causes of this condition are well known; however, they will be briefly outlined in the following.

Grain Growth and its Cause

When low-carbon steel (that is, steel with a carbon content below approximately 0.20 per cent) is cold-worked within a certain "stress" range and is then annealed within a definite temperature range, a peculiar phenomenon occurs which is usually termed "grain growth." Under these conditions, the grains of steel may increase in size to a considerable extent, often reaching eighty times their normal size. While this condition will result only after annealing as indicated, the amount of cold-working to which the steel is subjected entirely controls the extent of the grain growth. A definite stress is necessary to produce a maximum grain growth. Any increase in the stress beyond this point will cause the grains brought out in the subsequent annealing process to decrease in size in inverse proportion to the applied stress. The stress may be increased to such an extent that no grain growth will be apparent even when annealing is carried on within the critical range previously referred to.

Annealing Temperature at which Grain Growth Occurs

The temperature range mentioned, within which grain growth is produced, after the critical load has been applied, lies between 1290 and 1650 degrees F. Under these conditions, particularly following the lighter stresses, this range will be reduced to from 1290 to 1435 degrees F. To a limited extent grain growth will be found after annealing between temperatures of about 1250 and 1290 degrees F. A good idea of the average grain size of hot-rolled low-carbon steel annealed at 1300 degrees F. may be obtained by referring to Fig. 1; the magnification in this case is 100 diameters. The grain size of this specimen may be considered as normal. In Fig. 2 is shown the same steel after it has been cold-worked to a moderate degree. When the sample shown in Fig. 2 has been annealed at a temperature of 1300 degrees F. it appears as shown in Fig. 3. The magnification in this case is also 100 diameters. A comparison of Figs. 2 and 3 will show that the size of the grain has been increased many times by the annealing process. It is evident that steel in the condition shown in Fig. 3 is unsatisfactory for stampings.

The grain growth in low-carbon steel may occur in a

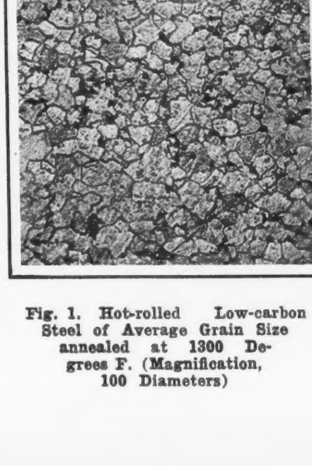


Fig. 1. Hot-rolled Low-carbon Steel of Average Grain Size annealed at 1300 Degrees F. (Magnification, 100 Diameters)

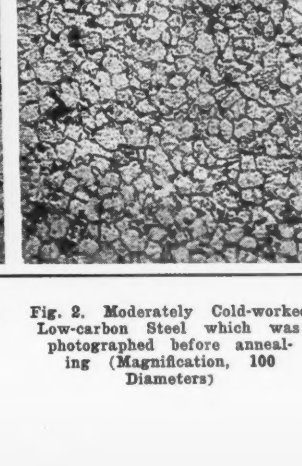


Fig. 2. Moderately Cold-worked Low-carbon Steel which was photographed before annealing (Magnification, 100 Diameters)

wide variety of products, the manufacture of which requires cold-working and annealing operations. For instance, grain growth often occurs in low-carbon steel wire, tubing, and sheet or strip stock, and in all these materials, the grain growth may seriously affect production. The conditions under which grain growth occurs are to be found in the manufacture of stampings when cold-working operations are followed by annealing. The manufacture of stampings may perhaps be considered the most complicated of all the processes, as far as eliminating the trouble caused by grain growth is concerned, for not only may grain growth result from the operations performed in producing the stamping, but it may also be present in the raw materials. This is true of hot-as well as cold-rolled sheet and strip stock. It will be apparent, then, that this factor may increase to a considerable degree the difficulty of planning production methods.

Grain Growth in Hot-rolled Stock

That grain growth may occur in hot-rolled sheet and strip stock may seem strange after considering the preceding explanations. The expression "hot-rolled," however, is purely relative in the sense in which it is used here, and covers material rolled under a range of temperature having an upper limit of about 1450 degrees F. This range may cover the temperature at which thin sheet or strip stock may receive its final rolling. Such material cools rapidly and may readily reach a temperature within the range at which grain growth occurs before the finish-rolling operation. At the end of the hot-rolling operation, the sheet or strip stock may retain its heat sufficiently long to admit of its being annealed within the grain growth range, particularly if it is placed in a pile while cooling.

Sheet and strip stock are affected by grain growth with a grain size varying from normal to a size as large as that indicated in Fig. 3. If the grain growth has been moderate, subsequent operations may not be affected to any extent, but if the increase in the grain size has been as great as that indicated in Fig. 3, the material will be exceedingly difficult to handle in the press room. Fortunately, much of the commercial sheet and strip stock is affected by grain growth to a very moderate extent so that further production processes may be carried on without any particular trouble from this source. Its occurrence is also usually limited to certain gages between approximately 1/8 and 1/80 of an inch in thickness. It seldom occurs in heavy or very thin stock.

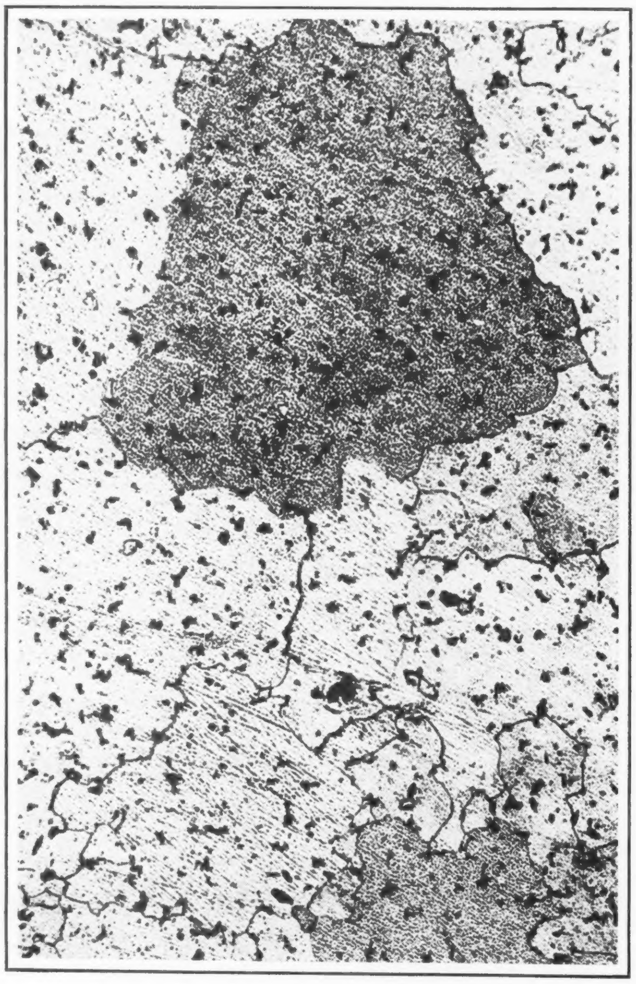


Fig. 3. Grain Growth produced in Low-carbon Steel by Moderate Cold-working followed by annealing at 1300 Degrees F. (Magnification 100 Diameters)

Restriction of Grain Growth

There has been considerable improvement in recent years in the restriction of grain growth in sheet metal, but its complete elimination as a commercial proposition is still to be accomplished. In spite of the increasing infrequency with which any great degree of grain growth occurs, it nevertheless crops out occasionally in its worst state. With cold-rolled stock it is possible, by proper annealing methods, to eliminate this condition entirely and to produce material of high drawing quality. This is commercially feasible only in the case of products that can absorb the increased expense incurred. When the wide variation possible in the condition of sheet and strip stock is considered, the question of eliminating unsatisfactory stock by test naturally arises. The occurrence of grain growth can be readily detected by microscopic examination and in many cases by tensile or other physical tests. Such tests are not easily applicable under commercial conditions, but they are valuable in supplying data for further investigation.

From the commercial standpoint, the information most desired is that which will distinguish between good and bad raw material. For this purpose several methods of testing have been introduced, nearly all of which are based on the drawing press principle. It is possible to test the drawing quality of the raw material on an experimental press using a small die and punch. When there is stock available such as may be obtained from corners that are to be trimmed, tests can be carried out on the stock from which the stampings are to be made. In this case the four corners of the blank can be tested. Such methods may be quite successful in some cases, but it is always well not to base results upon the depth of the draw attained, as material in poor condition may draw well under a moderate load or stress. After the test, the surface should be examined for grain growth. If grain growth occurs, the surface will be roughened to a degree dependent on the increase in grain size. Even moderately large grains may be detected in this way. This roughening of the surface may also be noted in stampings made from stock containing grains larger than normal size or introduced in the preliminary operations. Examination of the material at various stages in the production of a stamping may result in the detection of the source of grain growth, whether it occurs in the raw material or during the manufacturing operations.

Tests of the raw material such as have been outlined are very useful under certain conditions, but their practical application is by no means simple. It is hardly possible to test each individual sheet or strip of stock, and if it were, complete detection could scarcely be attained. Grain growth may occur in spots or in a considerable portion of the sheet stock. The selection of test samples for determining the condition of a shipment of stock may or may not be satisfactory, as the condition of a few sheets does not necessarily indicate the condition of the whole shipment, for the reason that individual sheets may vary widely in their condition. When annealed sheet or strip stock is to be tested, complications may enter due to uneven annealing, which may result in material that is too hard.

While testing methods such as outlined in the preceding paragraph may not draw a hard and fast line between satisfactory and unsatisfactory material, it is possible to apply them in ways that will be valuable commercially or at least so that they will be a definite detection against the acceptance of exceedingly poor stock. The troublesome conditions that may exist in the raw material may be paralleled exactly in the finished or semi-finished parts by faulty handling in the production processes. Grain growth may result through improper control of the annealing. As has been mentioned, it may be possible to control grain growth in some cold-working operations by applying loads that exceed the limits beyond which subsequent annealing operations can possibly have any effect. In the stamping processes, however, this simple method cannot always be applied. Grain growth may be controlled to some extent in simple cases by this method, but it would be very difficult, for instance, in the case of work having a slight bend, or where there is a variation in the gage of the stock. Some apparently minor or unconsidered pressure may also cause trouble.

Grain Growth in Stampings

How grain growth may occur in a stamping can perhaps be best shown by considering the drawing operation on a cup such as that shown in Fig. 5. It is evident that the metal will be drawn to a considerable extent in reducing the diameter of the blank to that of the shell, and that the metal is stressed the least at the bottom of the cup. In this case, it is assumed that the cup is drawn from the blank in one operation. The top or rim is subjected to the greatest stress, the stress decreasing gradually from the top of the cup to the bottom. If the cup is annealed within the critical range already mentioned, for which 1300 degrees F. has been selected as a representative temperature, the grain growth will occur very much as represented in Fig. 4. It will be noted that the largest grains occur near the bottom where the stress is the least and that they decrease in size toward the top, becoming practically normal before this point is reached. This could not be shown completely in the illustration on account of the limited space. The decrease, however, is apparent.

Fig. 4. Section of Cup Stamping annealed at 1300 Degrees F. (Magnification, 25 Diameters)

In such simple cases, it is possible to so control the stresses set up in different parts of the shell that troublesome grain growth will be eliminated. However, this may necessitate several drawing operations in place of one, in order to obtain the necessary uniform distribution of the stresses in the cup previous to annealing. The worst conditions frequently result from annealing after the first or second operation, even though the material is drawn but a small amount. It is evident that with few exceptions successive press operations should be carried on without annealing until it becomes absolutely necessary.

Peculiar results are often obtained by a slight variation in the methods of drawing and annealing. Take, for example, two plants making the same part and using the same steel. It will often be found that one plant may carry on the processes to the finished product without annealing or at least with a minimum number of annealing operations, while in the other plant the work may be annealed between each press operation, and yet entirely satisfactory results are not obtained in the latter plant. It is easy for such a variation in results to arise, if, in the case of the second plant, the work is annealed within the critical range after one of the first drawing operations. The introduction of grain growth in an early annealing operation may make it necessary to increase the number of total annealing operations and may also require an increase in the number of press operations.

Accurate Control for Annealing Temperature Necessary

If the prevention of grain growth is desired, annealing may be carried on either above or below the critical temperature range. If it is a case of removing grain growth from the work, the annealing must be done at a temperature above the critical range, that is, either above 1435 degrees F. or above 1650 degrees F., according to conditions. For this purpose the temperatures commonly used are 1450 degrees F. and 1700 degrees F. The latter temperature represents the point of complete refining.

In the annealing processes that may be selected to meet the needs of the individual case, accurate temperature control is, of course, necessary. It is, however, one thing to have accurate pyrometers and another thing to insure the heating of each piece to exactly the correct temperature. To a very marked degree, accurate control of the furnace temperature is dependent upon the furnace design and the furnace charging methods. Uniformity is required not only for production results but from the standpoint of economy as well.

Requirements of Annealing Furnaces

An annealing furnace must not only be capable of maintaining a uniform temperature with an empty hearth, but it must also heat the work uniformly and quickly to the desired temperature. Two general types of furnaces are used for annealing, namely, the over-fired, and the under-fired. It has been the writer's experience that the latter type, as a rule, is more easily controlled, more uniform in operation and can usually be operated at a lower cost. This may not be apparent if the cost is considered in terms of fuel consumption per unit of time. Costs, however, should not be figured on such a basis, but upon the production obtained.

The furnace charging methods, as mentioned, also have a considerable effect upon the results. If the furnace is so loaded or charged that a uniform distribution of the heat is prevented, the cost of the operation may be increased to a considerable degree and uniform results be impossible of attainment. When retorts are used for annealing, care must be taken to have them arranged so that each surface will receive as nearly the same amount of heat as possible. The size and shape of the retorts may also have an effect upon the uniformity of the product. When open fire annealing is practiced, interference with heat distribution may result from loading the furnace too full or from an irregular arrangement of the work. In any case, much time can be lost in waiting for part of the load to reach the desired temperature when a considerable portion is ready to be removed from the furnace. Furthermore, the overheating of part of the work that occurs under the conditions mentioned will naturally result in non-uniformity in the product.

Fuel for Annealing Furnaces

The fuel available will, of course, influence to some degree the design of the furnace. At present the choice appears to lie between coal or coke, gas, and oil, with general conditions in favor of the latter. Electricity is used in some cases, but its cost is usually too high to permit of its general adoption both as regards installation and operation. Gas is perhaps the most satisfactory fuel of the three first mentioned, but its cost may be high and it may not be readily available. Coal and coke have been used to a considerable extent, but present considerable difficulty in handling. The results obtained in the average furnace in which these two fuels are burned can hardly be called uniform. With a natural draft its speed of operation is affected by weather conditions. Oil is probably the best fuel to use, considering the factors of cost, availability, and ease of operation. However, the furnace must be carefully designed if this fuel is to be used. It is particularly necessary that the combustion chambers be of ample height.

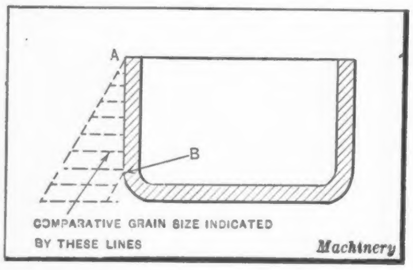


Fig. 5. Drawn Cup used as Example to illustrate Growth of Grain Size

In considering the cost of operating an oil furnace, it is well to remember that some of the heavier varieties of oil can be obtained at a comparatively low price and that a considerable saving in operating costs will result if the installation is designed to handle the heavier rather than the lighter grades of oil. The furnace design will be influenced to some degree by the method of annealing adopted, but the general principles of furnace design will be the same for both the open-fire and the retort methods. If the product is required to be free from scale this determines in a large measure which method of annealing is to be adopted. This factor is of less importance in general production than might be assumed. If annealing is carried on just below the grain growth temperature practically no scale will be formed. When higher temperatures are required, it is possible, by simple and inexpensive "pickling" methods, to produce work that is sufficiently clean and satisfactory as a commercial product when the open-fire method is used.

Except in cases that have been proved definitely to require retort annealing, the choice should be based largely on the cost. From this standpoint, open-fire annealing will usually have the preference. This is by no means universally true, however, for the reverse may be the case in some instances. Size, shape, weight, conditions of handling, and other similar factors must be taken into consideration. As a rule, the heavier stampings can be open-fire annealed to better advantage and at less cost, particularly if small evenly distributed heats are used which can be handled quickly.

It should not be forgotten, however, that the design of the parts to be made, the design and the condition of the dies and punches, the variation in the gage of the stock, and various other factors must be taken into account. The design of the part may be such that undue strains are introduced which cannot be avoided. Then, again, the press tools may be soft or improperly finished, or the drawing operations may be carried to a point beyond the endurance of the steel. With so many factors involved it may be difficult to determine whether the cause of failure is mechanical or whether it lies in the condition of the steel. If fracture occurs, it is possible to determine the reduction in the thickness of the metal at the fractured point. When this is 50 per cent or more, it may be generally assumed that the condition of the metal is reasonably satisfactory

INCREASING THE SCOPE OF TABLES OF SQUARES

By SAMUEL KAUFFMAN

The tables of squares in MACHINERY'S HANDBOOK which run up to number 2000 in increments of 1, may also be used to quickly obtain the squares of numbers not given in the tables. In designing, the writer is continually required to find the square of dimensions consisting of four or five figures, the last of which is 5; it is with combinations of this sort that he finds the tables to be of invaluable service. Assume, for instance, that it is necessary to find the square of 319.5. To square this number by multiplication is tedious, and the use of logarithms is a roundabout process in comparison with the method here described.

Consider 319.5 as the arithmetical mean of 319 and 320; then from page 8 of MACHINERY'S HANDBOOK, obtain the values for the squares of these two numbers, add them together and divide by 2. Next, in the quotient place the figure 2 between the last figure on the right-hand side and the one preceding it. The last figure will always be 5 because the sum of the squares of two consecutive numbers is always an odd number, and dividing any odd number by 2 obviously makes the last figure of the quotient 5.

Proof of Method

$$319^2 = 101761$$
$$320^2 = 102400$$
$$\text{Adding} = 204161$$

Dividing by 2,

$$204161 \div 2 = 1020805$$

Placing the figure 2 at the left-hand side of the last figure, we have 10208025. Next, placing the decimal point according to the common rules of multiplication, $319.5^2 = 102080.25$. This result can be readily proved by squaring the number by multiplication. Similarly, $31.95^2 = 1020.8025$ and $3.195^2 = 10.208025$.

That this method is especially useful in finding the square of numbers having a decimal fraction equivalent to eighths, quarters, and sixteenths inch will be apparent from the two following examples:

Example 1—Square 12.125.

$$1212^2 = 1468944$$
$$1213^2 = 1471369$$
$$\text{Adding} = 2940313$$

Dividing by 2,

$$2940313 \div 2 = 14701565$$

Placing figure 2 at the left of the last figure, we have 147015625.

Finally locating the decimal point properly,

$$12.125^2 = 147.015625$$

Example 2—Square 1.1875

$$1187^2 = 1408969$$
$$1188^2 = 1411344$$
$$\text{Adding} = 2820313$$

Dividing by 2,

$$2820313 \div 2 = 14101565$$

Placing figure 2 at the left of last figure we have 141015625. Then

$$1.1875^2 = 1.41015625$$
$$11.875^2 = 141.015625$$
$$118.75^2 = 14101.5625$$

* * *

The Northwestern Railway of India has made exhaustive tests of a new type of concrete railway tie. These ties have been used on 50 miles of main line track and consist of two concrete blocks joined together by a tie bar. Wooden plugs, specially treated and compressed, are set in the bed of the concrete block, and the rails are fastened to the ties by means of screws or spikes driven into the wood.

Reducing Costs by Disk Grinding

Typical Examples of Work Finished on Disk Grinding Machines

By CHARLES O. HERB

GREAT strides have been made in disk grinding practice since the days when machines of this type were used only for polishing and very light finishing operations. In up-to-date plants where stress is laid upon quantity production at the lowest possible cost, parts formerly finished on the milling machine and planer are in numerous instances now finished satisfactorily and economically on disk grinding machines. The initial cost of most disk grinding machines is much less than that of a milling machine or planer, and if a work-holding fixture is desirable, it is generally of simpler design than would be required on either of the other two machines. The cost of replacing and dressing the abrasive disk also compares favorably with the first and the resharpening costs of milling cutters and planer tools. However, the main advantage of disk grinding lies in the high rates of production obtainable. This article describes a number of operations performed on grinding machines of this type and gives the production rates obtained.

Different Types of Machines Available

Disk grinding is employed principally for truing plane surfaces by holding the work in contact with a revolving abrasive disk. On the single-spindle machine, which is the most common type, the work is simply held against the disk by hand or by placing a surface opposite to the one to be finished against an angle-plate on the table of the machine. The table may be at right angles or some other angle to the face of the wheel and fed toward it by manipulating a lever. Special fixtures are also employed for carrying the work to the disk. This machine is designed with a disk at each end of the spindle to permit two operators to work simultaneously, as shown in the heading illustration.

Such operations as grinding parallel sides of piston-rings, wrenches, cap-screw heads, and hexagon nuts are best performed on a double-spindle machine. The two spindles are mounted in line, and carry an abrasive disk on the adjacent ends. The piece or pieces to be ground are placed in a work-holding device, advanced between the grinding disks, and ground in some machines by bringing the two disk heads together simultaneously, and in others by advancing only one head, the other one being in a fixed position. The table or work-holding device on both the single- and double-spindle machines is so constructed that an oscillating movement may be given to the work across the face of the grinding disk.

Work that is relatively large, such as automobile crankcases, can be handled best by a gravity-feed or vertical-spindle machine in which the disk rotates in a horizontal plane. The surfaces are ground by resting the work directly on the rotating disk, bars being placed across the disk to prevent the work from revolving with it. If the weight of the work is not sufficient to produce a satisfactory pressure against the disk, weights may be placed on top of the work or it may be held down by hand, as shown in Fig. 1. One prominent manufacturer of disk grinding equipment states that this pressure should be from 15 to 20 pounds per square inch, while another says that a pressure of 7 pounds per square inch gives good results.

The Gardner Machine Co., Beloit, Wis., builds a machine of the vertical-spindle type equipped with a continuously rotating column on which are mounted tables with holding-faces at right angles to the disk. Fixtures may be attached to these tables, as shown in Figs. 4 and 6, for carrying parts across the disk and grinding the bottom surfaces. The tables and work are automatically lowered on the disk to remove a predetermined amount of stock. Gravity pressure is also relied upon in this machine for performing the operation; however, there is an adjustment for regulating the pressure. The chief advantage of this machine is its high production rate which is obtained through the use of revolving work-holding fixtures.

Fig. 1. Finishing Tractor Air-strainer Bodies and Covers on a Disk Grinding Machine of the Vertical-spindle Type

Another recent development is an automatic double disk grinding machine for rapidly finishing parts having two opposite parallel sides of approximately equal area, such as piston-rings, electric iron plates, ball and roller bearing races, and gear blanks. In this machine the work is fed either from a magazine or by the operator into openings in a large continuously rotating wheel which carries

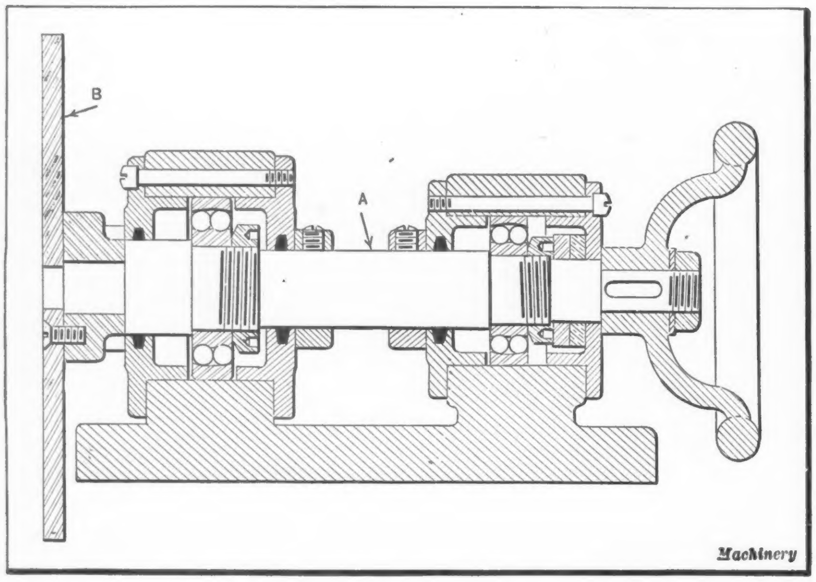


Fig. 2. Special Fixture designed to permit Easy Rotation of Piston-rings while being ground

the work past the disks. The openings are shaped to fit the periphery of the work. A unique feature of this machine is the arrangement of the disk spindles, which are offset relative to each other, so that the work is ground on the front face of one disk and on the rear face of the other. One head is fixed, while the other advances and applies its disk to the work under constant spring pressure. The rate of production on this machine varies from fifteen to sixty pieces a minute.

Abrasive Disks and Ring Wheels

The advances in the design of disk grinding machines have been possible because of the progress that has been made in the manufacture of abrasive disks. The first abrasive disks were made of commercial emery cloth or paper, the abrasive never being coarser than No. 36 grain. While such disks are efficient for polishing, they are inadequate for grinding off stock. Later, glue-bond artificial abrasive disks were developed, and now the heaviest service is obtained with cement-bond disks. Glue-bond disks are usually about 3/32 inch thick, while the cement-bond disks are about 1/4 inch thick and wear from three to ten times as long as the former. The grain size of disks now made by one manufacturer ranges from No. 10 to 180. As coarse a grain as possible should be selected for a job, because the coarser grain obviously removes stock faster than a fine one. However, the coarseness is limited by the degree of finish desired. The efficiency of an abrasive disk depends considerably upon the care with which it is attached to the steel disk wheel.

In instances where wet grinding is desirable, as when a large amount of stock must be removed, grinding wheels of the ring type are used instead of the regular steel disks faced with cloth-backed abrasive disks. Wet grinding is also necessary in grinding steel castings and hardened parts in which the hardness might be destroyed by excessive heating. For this work solid disk wheels are employed. Disk grinding is applicable not only to iron and steel, but also to aluminum, brass, and other soft metals, and disks of different bonds are manufactured to suit these various metals. The softer metals have a tendency to load the disk, and in order to prevent this, it is sometimes necessary to apply wax on the disk faces, so as to fill the spaces between the abrasive particles. After grinding until the disk seems to be cutting less efficiently, the wax and the metal chips which it holds are removed by passing a wire brush over the disk. Then wax is again applied to the disk and the operation proceeded with as before.

Disk-grinding Piston-rings to Width

Although the cleaning of a casting surface by holding it against the abrasive disk without the aid of a special fixture is the type of job for which the disk grinding machine is particularly applicable, it is also possible to grind work within close limits when the proper fixtures are used. On the Gardner automatic double-disk machine, automobile piston-rings have been ground to a thickness of 3/16 inch within plus and minus limits of 0.0005 inch. In removing 0.015 to 0.018 inch of stock from Ford piston-rings, 3 3/4 inches in diameter by 1/4 inch thick, a production of about 18,000 rings per ten-hour day is obtained. The disks are dressed only about once a day, and last for from 30,000 to 50,000 rings.

Piston-rings for air compressors are also ground within close limits on a single-spindle machine by employing the special fixture illustrated in Fig. 2. This fixture enables the ring to revolve freely with the wheel during the grinding operation, which results in a higher grade of finish than when the part is held stationary relative to the wheel or simply oscillated back and forth. It will be seen that shaft *A* of the fixture is provided with two self-aligning ball bearings so that it will rotate easily when the piston-ring is brought in contact with the disk. Faceplate *B* is provided with three studs, between which the ring is seated for the operation. The handwheel on shaft *A* permits the shaft to be retarded when the work is first brought in contact with the disk, and also furnishes a means of starting it at the proper time. When one side has been ground, the ring is reversed on the faceplate for grinding the opposite side. These rings are individual iron castings eight inches outside diameter, and are ground to a thickness of 3/8 inch, from 1/64 to 1/32 inch of stock being removed. Accuracy is obtained in the operation by grinding to a stop. The production averages forty-five rings per hour.

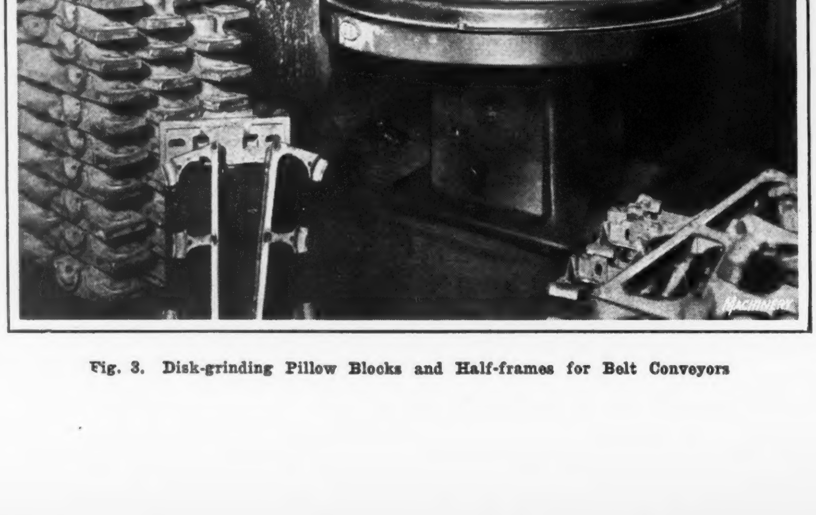


Fig. 3. Disk-grinding Pillow Blocks and Half-frames for Belt Conveyors

A magnetic chuck could also be employed in an operation of this nature.

Work Performed on Vertical-spindle Machines

An operation typical of the class of work for which plain vertical-spindle machines are adapted is illustrated in Fig. 1. This consists of finishing the joining surfaces of water air-strainer bodies and covers for tractors. The machine is a Gardner No. 24, equipped with a No. 126 grain, 53-inch G.I.A. cement-bond disk. The average rate of production is thirty-five bodies or twenty-five covers per hour. Another operation performed on the same type and size of machine is shown in Fig. 3. This consists of finishing pillow-blocks and half-frames for belt conveyors. With a No. 166 grain, 53-inch G.I.A. disk, the production is thirty-five pillow blocks or forty-five half-frames per hour.

Large savings have been effected by the Toledo Scale Co., Toledo, Ohio, through the installation of a vertical continuous-feed grinding machine for finishing parts formerly milled. Small parts that were milled at the rate of seven pieces per hour, are now finished at the rate of seventy to seventy-five pieces per hour, which represents an increase in production of 1000 per cent. Large pieces just within the capacity of the grinding machine are produced at the rate of sixteen pieces per hour, as against four pieces per hour by milling. On the average run of work, the production ratio is eight to one in favor of disk grinding on the continuous-feed machine compared with milling. One distinct advantage that the continuous-feed machine has over the plain type is that the surface being ground is at right angles to the holding surface of the table.

Two different views of the machine used in the plant of the Toledo Scale Co. are shown in Figs. 4 and 6. A continuous flow of three different parts is obtained on this machine by equipping it with special fixtures to suit each part. Fig. 4 shows a close-up view of fixture used for holding the smallest of the three parts. This fixture has a swinging member that is raised for loading, and locked down to hold the work in place. The remaining two fixtures may be seen clearly in Fig. 6, the one at the right being employed for holding a large ring casting on which the base is ground, and the one at the left, for holding a casting similar to that shown in Fig. 4, but of larger dimensions.

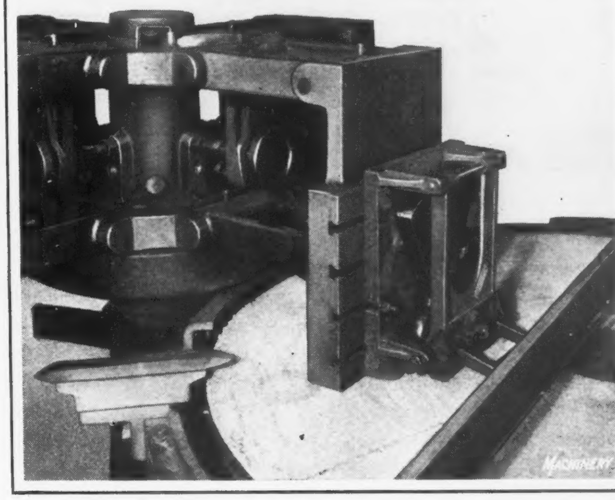


Fig. 4. Typical Disk Grinding Operation on a Continuous-feed Machine

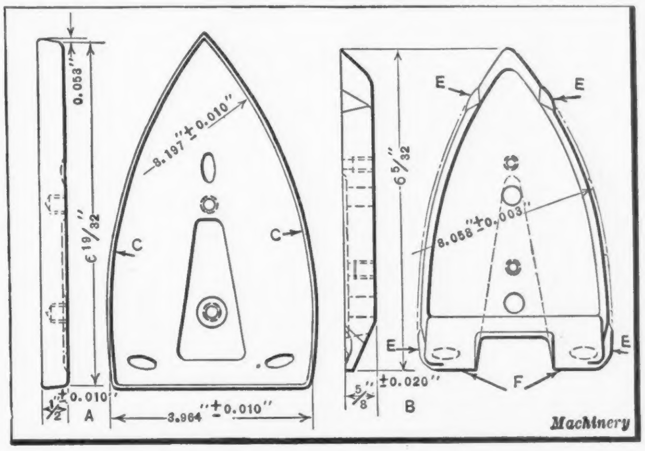


Fig. 5. Sole and Pressure Plates of an Electric Iron which are Excellent Examples of Disk Grinding

Finishing the Top and Bottom of Electric Iron Plates

An interesting disk grinding operation conducted at the plant of the Edison Electric Appliance Co., Inc., Chicago, Ill., consists of grinding the top and bottom of the sole plate shown at *A*, Fig. 5, in a Gardner automatic double-disk machine. These plates are iron castings with variations in thickness amounting to 1/8 inch, and must be ground to within a plus or minus limit of 0.010 inch. Both sides are ground to size in one pass through the machine at an average production rate of 300 pieces per hour. As the machine was originally built, the work-carrier rotated in one direction constantly, and the work was given an uninterrupted movement between the two grinding disks. However, this method was at times unsatisfactory, because of the large amount of stock that had to be removed from some castings, which made the work tend to gouge the disks.

In order to eliminate this trouble, a special mechanism was attached to the machine, which, by means of cams and clutches, imparts three backward and forward oscillations to the work-carrier in conveying each plate between the disks. In this way, lighter cuts are taken, and this has resulted in twice the production formerly attained. The same amount of stock is removed, but a larger area of the disk is employed in removing it. When three oscillations of the work-carrier have been made, the carrier indexes to bring a new piece into contact with the disks, the preceding plate being ejected by a spring-actuated roller. The movable grinding head feeds toward the work at a uniform rate, while the carrier

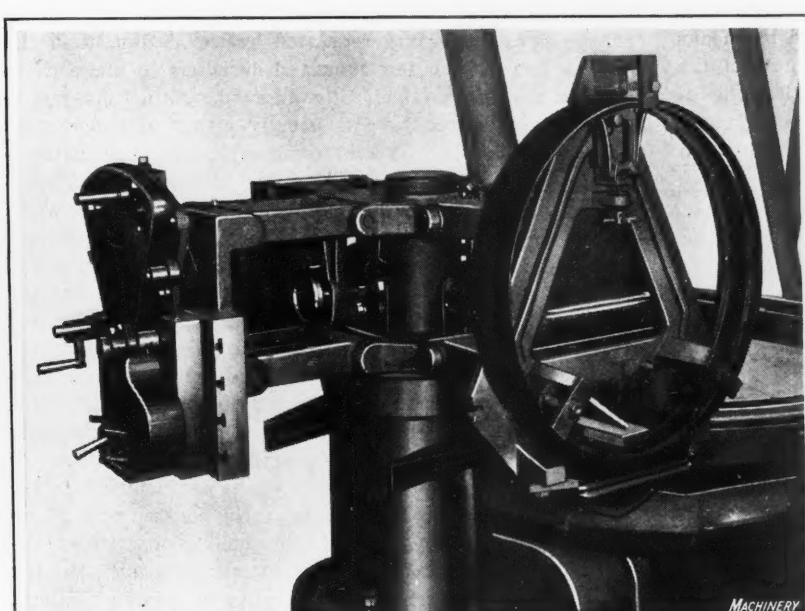


Fig. 6. Continuous-feed Machine equipped with Fixtures for Different Kinds of Work

oscillates and withdraws during the indexing. This is a wet grinding operation, and is performed with Norton ring wheels, a grade K grain 16 wheel being used for the bottom of the plate, and a grade K grain 24 for the top. A wheel of coarser grain is used for the bottom because this surface is later polished, whereas the top surface remains as it comes from this operation when the plate is assembled in the iron.

Grinding the Curved Edges of Sole Plates

An ingenious mechanism has been applied in the same plant to a No. 4 single-spindle machine for grinding the curved edges *C* of sole plates. Opposite each grinding wheel, represented diagrammatically at *A*, Fig. 7, there is a continuously revolving fixture *B* on which the sole plates are placed. The fixture located at the right revolves in a counter-clockwise direction, while that at the left revolves clockwise; hence, one edge of the sole plates may be ground on one wheel and the opposite edge on the other. As the plates are taken from the first fixture they are placed on a gravity conveyor that carries them to the operator at the other side of the machine. The production averages 1680 sole plates per hour, ground along both edges. The grinding is performed dry with a Sterbon grade L grain 12 ring wheel.

Each fixture has six stations for the sole plates, as illustrated diagrammatically in Fig. 8. Accurate locating of the work is insured by means of nest blocks *E* and *F* interposed between the sole plates and against which the plates are held by means of spring-actuated rollers. The plates pass beneath a spring pad in front of the wheel during the actual grinding, which holds them down, while the nests, and an additional part, not shown, function similarly. The taper of the edges of the work as shown at *A*, Fig. 5, is 0.053 inch for the ½-inch width. The taper is produced by the fixtures being tilted in relation to the face of the grinding wheels. This special unit is driven from a motor located midway between the two fixtures, power being transmitted to driving shaft *C*, Fig. 7, through spur and worm reduction gearing. The motor runs at 1200 revolutions per minute, and the driving shaft at eight revolutions per minute. The speed is further reduced through gearing to rotate the fixture four times per minute.

Lugs *E* on the pressure plate shown at *B*, Fig. 5, must also be ground accurately to a radius, and this is accomplished on a Gardner No. 2 single-spindle machine by holding the plate in a fixture so arranged that the plate may be swung into contact with the grinding wheel. The grinding wheel is dressed to the radius of the finished lugs. The location of the work on the fixture is determined by means of gage-blocks, a central pin that fits the front hole of the pressure plate, and a rear pin that contacts with one of the lugs *F*. After the lugs *E* on one side have been ground, the plate is reversed in the fixture for grinding the lugs on the other side. This fixture is oscillated back and forth during the operation. The production averages 350 plates per hour, and a Carborundum grade N grain 36 ring wheel is used.

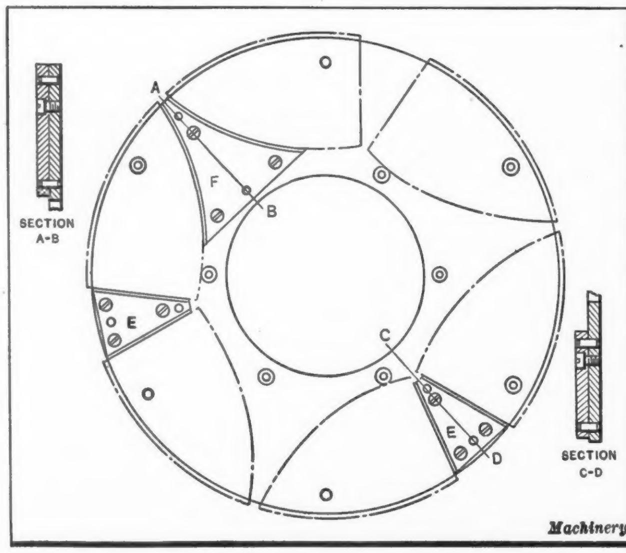


Fig. 8. Arrangement of the Six Work Stations on the Continuous Rotary Fixture for Sole Plates

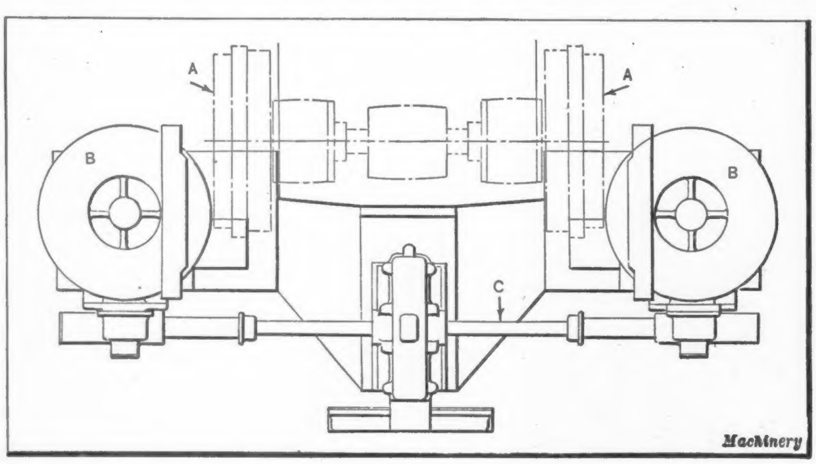


Fig. 7. Diagram of an Arrangement applied to a Single-spindle Machine for obtaining High and Accurate Production in grinding the Edges of the Sole Plate

* * *

COOPERATION OF ENGINEER AND DESIGNER

In June MACHINERY, page 771, an article was published dealing with the cooperation of engineers and designers in manufacturing plants. The writer of this article gives the impression that engineers as a rule make it a practice to suggest relatively unimportant detail alterations merely for the sake of altering, and, while this may be true in many cases, it should be remembered that, on the other hand, many designers do not fully appreciate the necessity for carefully studying every detail in relation to the available manufacturing equipment, so that its production can be as rapid as possible under existing conditions.

When anyone starts out to design a machine, it is not merely a case of producing a machine which will give certain specific results, but rather the evolving of a design which will give the results with a minimum outlay for its own production. A machine may have a hundred units, yet it is quite possible that each one of these units may involve ten or more operations or a thousand operations in all. Now if there are several alternatives in each of the operations and they are regulated by the design, then the designer has quite a few thousand decisions to make as to which is the best method to be adopted. As a consequence of this complication there is usually plenty of opportunity for the engineer, or machine shop foreman or patternmaker, or molder to suggest amendments to the design that may be well worth while. The first step in the direction of efficient production is undoubtedly the cutting out of the design of all unnecessary work, and the best way to do this is to ask the foremen to study carefully every detail with which they are concerned and make any suggestions that may lessen the cost of production.

Every foreman or departmental manager should be encouraged in the belief that he is one of a team whose main object is the general well-being of the concern and all its employes—that he has a particular interest in all matters relating to the works. From this point of view alone, enthusiastic cooperation in the way of criticism of new designs, is well worth securing. P. E.

Design of Punching and Shearing Machines

Calculating and Laying Out Frame Sections—Fourth and Concluding Article of a Series

By A. LEWIS JENKINS, Professor of Mechanical Engineering, University of Cincinnati

THE pendulum and slide of punching and shearing machines are kinematically equivalent to the slide-crank mechanism shown diagrammatically at X in Fig. 1, where line ob represents the crank and bd the connecting-rod, the slide being attached at d. The forces acting on the slide are the force W required to punch the hole, the reaction Q against the guide and the thrust on the pendulum or connecting-rod. The triangle abd may be taken as the force diagram where $ad = W$, $ab = Q$ and bd or L is the thrust on the pendulum. Force W has its maximum value when the punch has entered the plate a distance equal to the depth of penetration, and this usually occurs when angle c (see also Fig. 3 of the third article of this series published in September MACHINERY) is near 90 degrees. At Y, Fig. 1, is drawn a diagram of the forces when angle c is equal to 90 degrees.

Referring to the diagram it is evident from geometry that

$$\frac{W}{Q} = \frac{ad}{ab} = \sqrt{\frac{L^2 - e^2}{e}} = \sqrt{\frac{L^2}{e^2} - 1}$$

Solving for Q, the reaction on the bearing,

$$Q = \frac{W}{\sqrt{\frac{L^2}{e^2} - 1}}$$

From Fig. 2, which is a duplicate of illustration Y in Fig. 5 of the first article of this series which was published in July MACHINERY, the area of the bearing is nC. Denoting the unit bearing pressure by p,

$$Cnp = Q \quad \text{or} \quad n = \frac{Q}{pC}$$

Substituting the values found in the foregoing for Q,

$$n = \frac{W}{pC\sqrt{\frac{L^2}{e^2} - 1}}$$

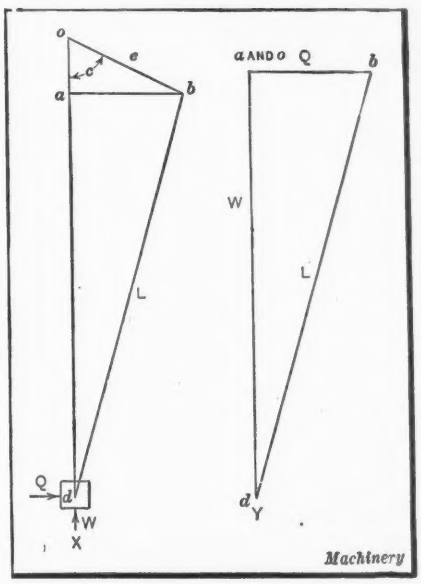


Fig. 1. Diagrams of Forces on the Slide-crank Mechanism

This value approximately equals $n = \dfrac{We}{pCL} + 2.5$. By making $p = 300$ pounds and substituting in this formula the following approximate values: $C = 4\sqrt{dt}$, $L = 6\sqrt{dt}$, $W = 188{,}500\,dt$ and $e = 0.55\sqrt{dt} + 0.15$, all of these values having been determined in the previous articles of this series,

$$n = \frac{188{,}500dt\ (0.55\sqrt{dt} + 0.15)}{300 \times 4\sqrt{dt} \times 6\sqrt{dt}} + 2.5 = 14.4\sqrt{dt} + 6.43$$

Thickness Y of the guide, Fig. 2, should be much greater than the ordinary conditions of operation demand. If the guide is considered as a uniformly loaded cantilever beam, the bending stress should not be greater than about 1000 pounds per square inch. This is apparently a very low stress for such a condition, but in view of the fact that the guide may receive an overload due to accident, poor condition of tools, or ignorance on the part of the operator, it is considered advisable to make the thickness of the guide sufficient to prevent failure under the most adverse conditions. A broken guide cannot be easily repaired and usually necessitates a new frame which costs almost as much as a new machine. The side thrust due to a slitting shear may equal up to 1.5 times the vertical force on the shear when the tools are very dull, and may be assumed equal to the force for which the machine is designed as a punch, in which case a working stress as high as 5000 pounds per square inch may be used. For ordinary working conditions the thickness of the guide may be found by the empirical formula $Y = 2.25\sqrt{dt} + 1$.

The increased thrust on the guide in shearing and in punching, when there has been negligence on the part of the operator, has been the cause of the lower portions of both guides breaking. To guard against such a contingency the lower portions on both guides are reinforced by a lug of thickness f which may be found by the formula

$$f = 1.5\sqrt{dt}$$

Length y of the reinforcement should be

$$y = 0.75n$$

A portion of the reinforcement is finished and provided with holes for attaching a stripper or other tools.

Holes are sometimes cored in the bottom of the guides to increase the clearance of the bolts in the flange of the slide and to facilitate putting them in. Thickness b of the rear wall of the head should be

$$b = 2.25\sqrt{dt} + 1$$

Width a in the head is equal to the width of the slide ($a = 11\sqrt{dt} + 1.4$) plus the thickness of the gib. If the gib is fastened to the frame, value a varies according to the taper on the gib and guide. The outside breadth of the head $B = a + 2Y = 15.5\sqrt{dt} + 3.4$.

If the back of the slide is reinforced at the bottom to decrease the stress due to the thrust of the punch stem, it is necessary to make room for it by removing some metal at the bottom of the head, as shown. The center of the bearing in the head is at a distance m from the top, equal to $\dfrac{n}{2} - 2e = 6.09\sqrt{dt} + 2.91$ in which e again represents the eccentricity of the camshaft. Width w of the frame behind the head may be made equal to a or a little greater. It is well to make

$$w = a + \sqrt{dt} = 12\sqrt{dt} + 1.4$$

Dimensions of the head which are not here determined were dealt with in the second article of this series.

Solid and Box Frame Sections

Many different cross-sections are used in designing frames for punching and shearing machines, all of which may be classified under two heads: (a) Hollow or box sections as shown at B, C, D, E, F, G, and H, in Fig. 3; and (b) solid rectangular and T-sections which are used on small machines, and the I-section shown at A in Fig. 3.

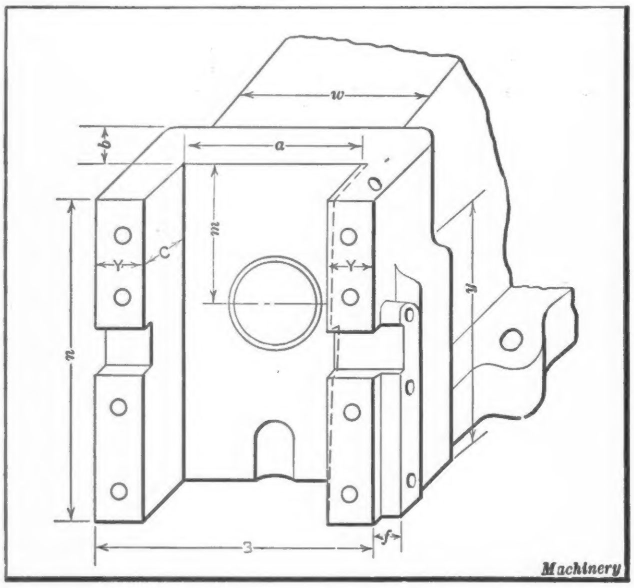


Fig. 2. Detail of the Frame Head on a Punching and Shearing Machine

Hollow sections have a greater torsional resistance and are supposed to have equally as great a bending resistance as an I-section. They are considered best for punching machines subjected to other than normal vertical loads such as may be caused by the die striking the work unevenly; and for the frames of shearing machines that are subjected to considerable twisting, due to eccentric loading or to a thrust perpendicular to the shear blades when they are set parallel with the jaw and not across it. There is considerable twisting moment on the frame when the machine is used for shearing, regardless of whether the shear blades are parallel or perpendicular to the front of the machine. In the first case it is due to the force on the shear at the beginning and the end of the cut, and in the other it is due to the thrust perpendicular to the blades.

Solid sections are used extensively in the design of frames for riveters and punches subjected to centrally acting loads and not subjected to twisting due to unevenness of pressure on the dies or eccentrically placed loads. A great many punching and shearing machines are also constructed with solid I-sections similar to the one shown at *A*. Some designers limit the use of such sections to machines not subjected to eccentric loads. The I-section costs less to mold as it requires only a core for the shaft instead of for the entire body, which also lessens the cost of patternmaking and eliminates the possibility of the frame being deformed by improper placing or securing of the core in the mold which sometimes causes the side walls of box sections to have unequal thicknesses. It is the opinion of some that I-sections are stronger than box sections of the same corresponding dimensions and having the same moduli of sections, but the results of tests made by Professor Benjamin indicate that box sections are stronger. The web of an I-section is twice as thick as the walls of a box section, and cools nearly as slowly as the flange, which should reduce the initial stresses due to cooling in the mold.

Cast iron is about five times as strong in compression as in tension, and in order to have a beam of equal strength in compression and tension the distance from the gravity axis to the extreme fiber in compression should be about five times as great as the distance to the extreme fiber in tension, but such a high ratio of these values cannot be realized in practice for several reasons. The web would have to be very thin and deep and the flanges heavy or wide; this would give a section hard to cast without initial stresses, which would not be rigid and which might buckle or otherwise fail under horizontal tensile stresses.

The thick compression wall at the bottom of the section at *B* brings the gravity axis nearer the center of the vertical sides than when this compression wall is thinner, as at *C*. However, it has been found from experience that it is unnecessary to have the compression wall thicker than the side walls. The I-section is equivalent to a box section with the side walls brought together to form the web, but as the small outside flange produced in doing this would usually be too small for good appearance, it is made thicker, and so the I-section is less economical in the use of material.

The sections shown at *B*, *C*, and *E* are quite likely to fail in the side walls at *ss* and *aa* by cracking behind the flange due to horizontal tension which will be considered later. The sections at *D* and *F* are strengthened to prevent failure behind the flange. The box section shown in Fig. 5 has the combined advantages of all the box sections shown in Fig. 3 and is widely adopted. Sections of the bottom jaw when the frame does not project below the floor line are shown at *G* and *H*, Fig. 3. These sections must have the same moduli as the sections of the upper jaw.

Formulas for Strength of Frames

Sections of the frame such as *P–Q* and A_3–*D* in Fig. 4, are subjected to the same conditions of stresses as a cantilever beam loaded at the free end. Hence, any section of either of the jaws is subjected to a bending moment equal to the product of the load and the distance from the load line to the section considered.

Thus

$$M = Wx = \frac{S_t\, I}{e_t} \quad \text{or} \quad S_t = \frac{Wxe_t}{I} \quad \text{and} \quad S_c = \frac{Wxe_c}{I}$$

in which

x = distance from load line to section considered:
M = bending moment;
W = force required to punch the hole;
L = throat depth plus clearance which is usually from ½ to 1 inch;
e_t = distance from center of gravity to extreme fiber in tension;
e_c = distance from center of gravity to extreme fiber in compression;
I = rectangular moment of inertia about gravity axis;
S_t = unit tensile stress at extreme fiber due to bending;
S_c = unit compressive stress at extreme fiber due to bending.

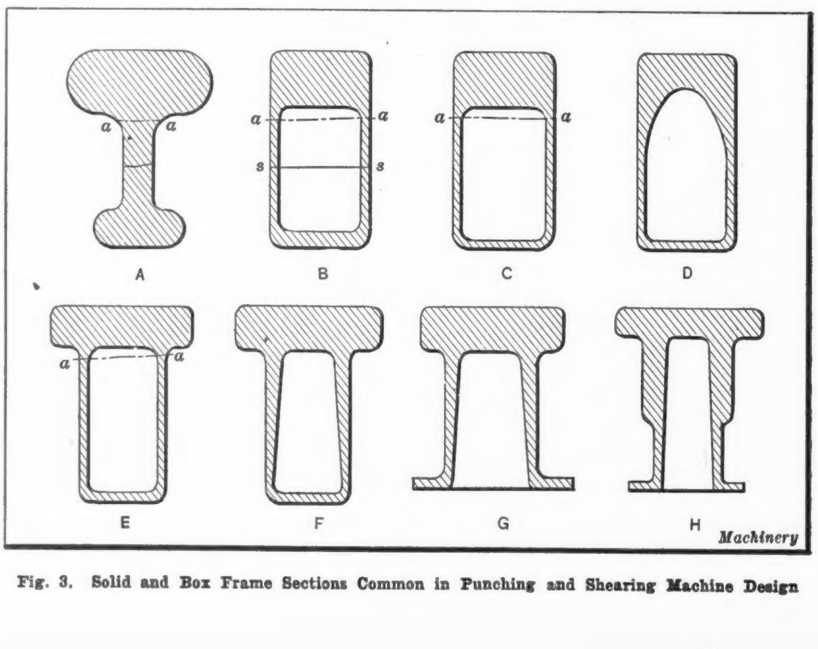


Fig. 3. Solid and Box Frame Sections Common in Punching and Shearing Machine Design

Values S_t and S_c for three sections are shown diagrammatically in Fig. 4.

Due to change in cross-section, the shear stress under the flange at line $a - a$ of sections A, B, C, and E, Fig. 3, may become appreciable and when combined with the tension at that point will give a maximum principal stress greater than the stress at the outer extreme fiber. It is therefore advisable to examine the section for the principal stress under the flange, or choose a section that does not have a sudden change in shape. A section which is suggested for use and which will not require such an investigation on account of its being sufficiently strong at this point is illustrated in Fig. 5.

To design the jaws of the frame for uniform strength would result in a zero section at the load line. It is only practical to reduce the section similarly to that shown in Fig. 4. On large machines the lower jaw is identical to the upper except at the end. The lower jaw extends below the floor line and is provided with a flange or lugs that rest on the floor or foundation. The frame in Fig. 4 has an open bottom, the section E–F being similar to that shown at G, Fig. 3. Small machines similar to that shown at Y, Fig. 6, have a cross-section through the lower jaw, as shown at H, Fig. 3. Considerable difference exists in the shape of the spine. A curved spine is provided on the frame in Fig. 4, and a straight spine on that at Y in Fig. 6. Radius R of the spine in Fig. 4 is not easily determined because the arcs at A_1 and B do not have the same center, and the radius of the arc passing through the center of gravity G is not easily determined in section A_1–B or in any other section.

The bending moment in any section through the straight portion of the spine at Y, Fig. 6, is the product of the load and the distance from the center of gravity G of the section to the load line. It may be expressed by the formula $M = W(L + e_t)$. The bending moment produces a maximum tensile stress equal to $S_t = \dfrac{Me_t}{I}$ and a maximum compressive stress equal to $S_c = \dfrac{Me_c}{I}$. These stresses are represented by the arrows between the lines ad and bc in the stress diagram for section $A_1 - B$ in Fig. 4. The load has an equal and opposite reaction through the spine which is denoted by W_1, and this force is equally distributed over the entire area A of the section and produces a uniform unit tensile stress S_w equal to $W \div A$. The stress S_w is represented diagrammatically between lines fg and hk.

Unwin's Curved Beam Formulas

The total stress S_1 at the extreme fiber in tension is the sum of the tensile stresses S_t and S_w and is represented by line mn. The total stress S_2 at the extreme fiber in compression is the difference or algebraic sum of the normal stresses at that point, the tensile stress S_w being subtracted because it is negative or acts in the opposite direction to the compressive stress S_c. The value of $S_c - S_w$ is represented by line op. From this explanation of the stress distribution it is easily seen that the maximum tensile stress S_1 on section A_1–B of a straight-spine frame as shown at Y, Fig. 6, is

$$S_1 = (S_t + S_w) = \frac{W(L + e_t)\,e_t}{I} + \frac{W}{A}$$

and the maximum compressive stress is

$$S_2 = S_c - S_w = \frac{W(L + e_t)e_c}{I} - \frac{W}{A}$$

These formulas are sometimes written

$$S_1 = \frac{W}{A}\left[\frac{(L + e_t)\,e_t}{r^2} + 1\right] \text{ and } S_2 = \frac{W}{A}\left[\frac{(L + e_t)\,e_c}{r^2} - 1\right]$$

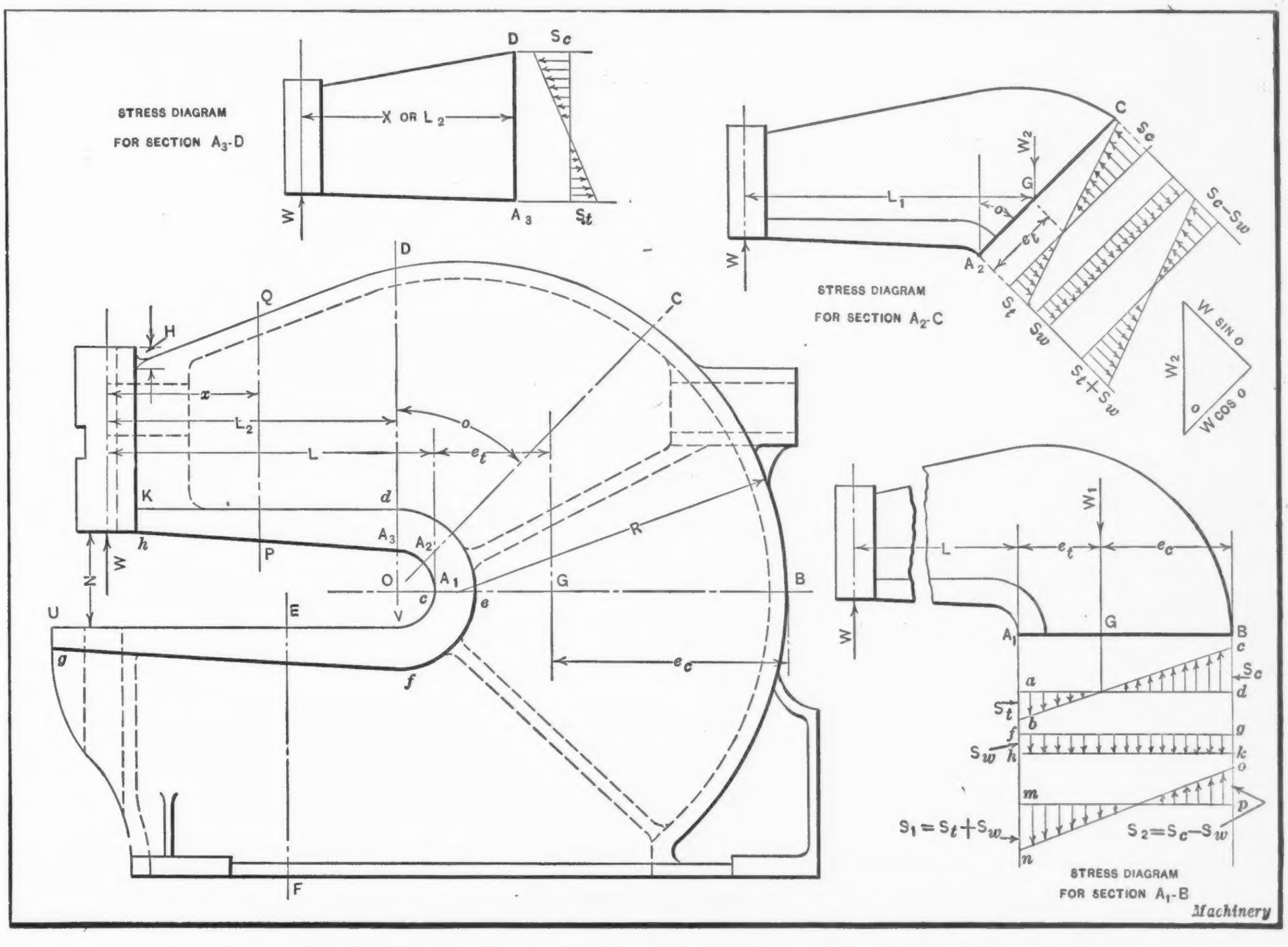


Fig. 4. Side Elevation of Typical Frame, and Stress Diagrams for Various Sections of the Frame

where r is the radius of gyration which equals $\sqrt{I \div A}$. These are known as "Unwin's" curved beam formulas and are supposed to be accurate for such sections as A_1–B when the spine is straight and of a material that obeys Hooke's law.

Section A_1–B of a curved-spine frame, as shown in Fig. 4, is not easily analyzed, because the curvature causes the neutral axis of the section to shift toward the tension side or center of curvature and thus it does not coincide with the gravity axis. The amount of shifting may be determined if the radius of curvature at the center of gravity is known and the material obeys Hooke's law, but there is difficulty in finding the desired radius, and cast iron does not obey Hooke's law. Formulas due to Résal, Pearson and Andrews, and Bach were developed in an attempt to find the stress in such a section, but they are all based on Hooke's law which does not apply to cast iron. These formulas are exceedingly difficult to use, requiring several operations involving the plotting of curves and measuring of areas with planimeters. The chances of error in the computations and measurements and the time required to perform solutions by them are considerations regarding their accuracy and use. However, such objections can cast no reflections on the theories upon which the formulas are based.

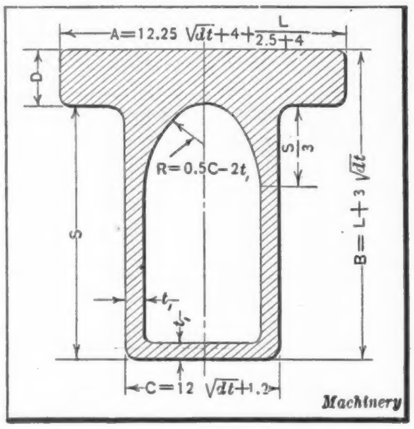


Fig. 5. Frame Section widely adopted in Punching and Shearing Machines

Tests on cast-iron specimens similar in shape to punch frames seem to indicate that Unwin's formulas for straight spines are more accurate for determining the breaking load for curved spines than those formulas based upon the more refined and complete theories. Texts on the strength of materials criticise their use as being incorrect for curved frames, but for materials having such poor elastic properties as cast iron the more elaborate theories for curved spines are actually not as accurate. Unwin's formulas require less work, involve less chance of error and are the only practical formulas that have ever been used in practice for the design of such sections. Until the elastic laws for cast iron have been substituted for Hooke's law in the Pearson-Andrews formula and a dependable method of solution has been devised the designer should use Unwin's formulas for the design of both curved and straight-spine frames.

Stresses on Section A_2–C

Section A_2–C at angle o with a vertical section A_3–D is subjected to a bending stress, a uniformly distributed tensile stress and a shear stress. The bending moment at this section is WL_1 (see the stress diagram for this section, Fig. 4) where L_1 is the distance from the load line to the center of gravity of the section. The load W must have a reaction in this section as it does for section A_1–B. The distribution of stresses for section A_2–C is shown in the stress diagram. The reaction W_2, resolved perpendicularly and parallel to the section as shown by the triangle below the stress diagram, gives a normal component equal to W sin o, which produces a uniform tension in the section A_2–C, and a component parallel to the section equal to W cos o which produces a uniform shear over the section. Hence the tensile stress due to bending is $S_t = \dfrac{WLe_t}{I}$. The tensile stress due to the normal component of W_1 is $S_w = \dfrac{W \sin o}{A}$ and the total maximum tensile stress is

$$S_1 = S_t + S_w = \frac{WL_1e_t}{I} + \frac{W \sin o}{A}$$

The shear stress is zero where the tensile and compressive stresses are maximum, and if the section is reinforced behind the flange similar to that shown in Fig. 5 the shear stress may be neglected. This is the only method of analysis that has ever been proposed for sections other than parallel or perpendicular to the load. The formulas due to Résal, Pearson and Andrews, and Bach are not applicable to frames with straight spines or to sections other than at right angles to the load as section A_1–B.

Failure of Frames Behind the Flange

Due to the web cooling before the flange after casting, initial stress is produced in the web, but this stress is small compared with the other stresses present when failure occurs. There is no shear in the spine or section A_1–B and in many cases frames have failed behind the flange as shown at Z, Fig. 6, by the walls or webs cracking along the line P–P. Many frames have the cross-section shown at E, Fig. 3, the thickness of the wall being the same throughout except at the flange on the tension side. This section would undoubtedly fail by cracking of the side walls where they join the flange. Radial ribs such as

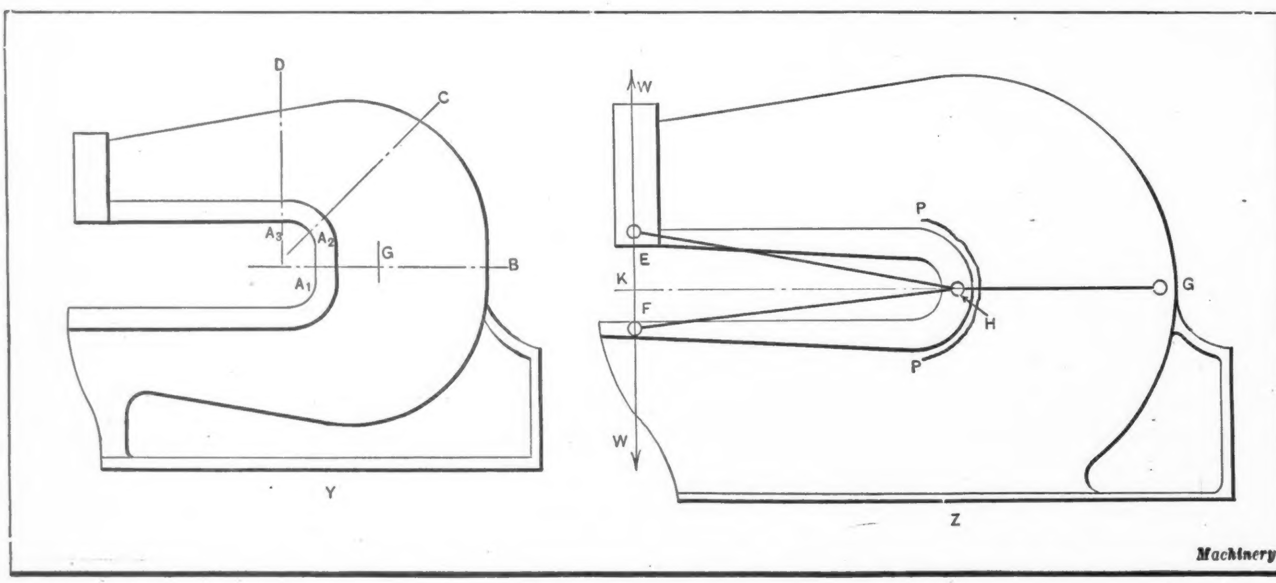


Fig. 6. Diagrams employed to illustrate Several Points to be considered in proportioning the Frame

shown dotted in Fig. 4 are also used to increase the strength of the frame behind the flange.

Results of tests on small specimens in which several failed behind the flange at a much smaller load than was predicted by formulas, indicate that such castings should be examined for similar failure, by the following method: Considering the inside flange as a separate member having pin connections at points E, H, and F at Z, in Fig. 6, and that H is tied to the outside flange by the link HG, the load W tends to increase the distance between points H and G. The stress in the link HG may be found as follows: Draw the lines HG, EH, and FH and let them represent links with pin connections; then produce GH until it cuts the line of load application at K. The triangle HKE may be taken as the force diagram where $KE = W$ and KH equals one-half of the total stress in the link HG. This stress is taken by a section of the web (or the side walls) the area of which is the distance PP measured around the outside of the inner flange, times the thickness of the web. The total stress in the web divided by this area will give the approximate unit stress in the web tending to produce failure as indicated.

The working stress in the frame when Unwin's formulas are used should vary from about 2000 to 5000 pounds per square inch or $S = 1150\sqrt{dt} + 1700$ for cast iron, depending upon the strength of the material used and the size and duty of the machine. It is well to use a working stress of 2500 to 3000 pounds per square inch in frames made of ordinary cast iron when 60,000 pounds per square inch is used for the ultimate shearing resistance of the plate; and a working stress of from 2100 to 2500 pounds per square inch when the shearing strength of the plate is assumed equal to 50,000 pounds per square inch. Small machines should be designed with a lower working stress than the larger sizes because small imperfections in the castings have greater effect on their strength. Also, the machines run at higher speeds and are more apt to be overloaded. In some instances the deflection should be considered, this being independent of the unit working stress.

Formulas for Various Dimensions

The section shown in Fig. 5 is designed to resist torsion and normal stress in the spine and the stress that tends to produce the failure indicated in Fig. 4. The proportions given in Fig. 5 are merely suggestions which assist in choosing a trial section and in every case they must be checked by Unwin's formulas. The width of the jaw at point U in Fig. 4 is equal to $12.25\sqrt{dt} + 4$, and the width of the flange increases 1 inch per each 2.5 to 4 inches of throat depth. Hence the width of flange at section A_1–B equals

$$A = 12.25\sqrt{dt} + 4 + \frac{L}{2.5 \text{ to } 4}$$

The width of the flange at K is made equal to B in Fig. 2 or $15.5\sqrt{dt} + 3.4$ and is tapered to meet the maximum width along line A_3–D. The thickness of the flange at section A_1–B is approximately equal to

$$D = \frac{L}{17} + 6.6\sqrt[3]{dt} - 2.67$$

and the thickness of the walls equals

$$t_1 = \frac{0.0615\,(L - 15)}{1.23 + \sqrt{dt}} + 1.13\sqrt{dt} + 0.82$$

The total depth B of the section is quite variable and any formula is no more than a suggestion for a trial value. In some instances it is well to try $B = L + 3\sqrt{dt}$.

The results of any of these formulas for the proportions of the sections cannot be taken as final unless they check with Unwin's formulas. They are merely intended to give some idea of the proportions for a trial section. In making changes in the dimensions after analyzing the trial section try changing the width of the flange and then the thickness or sometimes B, the thickness of the walls seldom requiring a change.

Lay-out of the Frame

The distance between the lower jaw and the slide when the latter is down is $8.25\sqrt[3]{dt} + 0.8$; thickness P (Fig. 4 of the first article of this series) of the flange on the slide is $\sqrt{dt} + 0.5$; and the clearance between the slide and the frame head when the slide is down and even with the top of the head is $2e + dt$, in which e represents the radius of eccentricity of the camshaft. Hence, the value of the jaw opening (see Fig. 4) $N = 8.25\sqrt[3]{dt} + 0.8 + \sqrt{dt} + 0.5 + 1.11\sqrt{dt} + 0.3 + \sqrt{dt} = 8.25\sqrt[3]{dt} + 3.11\sqrt{dt} + 1.6$.

There is considerable difference in the proportions of sections and general outlines of the frame. On some machines the flanges are of the same thickness throughout, and on others they are tapered. The same may also be said about the width of the flanges. Lines A_3h and gf in Fig. 4 may or may not be horizontal. The flanges may be rounded to resemble a semicircle or made rectangular and have the corners rounded with small radii. The outline of the entire frame may resemble a circle, a distorted rectangle, or have a shape intermediate between these two. In each case approximately the same strength is obtained at each section by varying the thickness of the walls or the flanges. The method to be here outlined results in a frame which differs from a number of other designs in general outline but has no particular advantage over them, unless that it is a little more economical in the use of material. The writer, however, considers the general appearance better.

After determining upon section A_1–B it is desirable to lay out the head to scale as shown in Fig. 4, making two views. Value N is then calculated, the horizontal line UV drawn, and the floor line drawn at such a distance below UV as will locate the die about 30 inches above the floor line. At this stage the designer may proceed according to any one of a number of different methods which will give satisfactory results so far as strength is concerned; but each method will result in a more or less different shape for the frame, and the one used by a designer depends largely on his conceptions of machine architecture.

One method consists in laying off points A_1 and B on a horizontal line drawn tangent to the top of the die, A_1 being a distance L from the load line and point B being a distance from A_1 equal to the depth of the section. The next step is to locate points C and D and draw the curve BCD. It is necessary to determine L_2 and locate A_3 before the section A_2–C can be determined. To get a trial value for A_3–D, draw an arc with the center at O on the line A_1–B and parallel to the horizontal line UV. Point O is also on the continuation of line A_3–D and $L_2 = L - A_1O$.

The width of the flange at A_3 is $12.25\sqrt{dt} + 4 + \dfrac{L_2}{2.5 \text{ to } 4}$

and the thickness of the walls is the same as in section A_1–B. The thickness of the flange at A_3 is usually less than the thickness of the flange at A_1, but sometimes they are made equal. The value of the flange thickness and depth A_3–D are determined by trial solutions, the dimensions being assumed and the modulus of the assumed section substituted in the formula for the stress of this section.

After locating D in this way, section A_2–C at 45 degrees with the vertical is treated similarly to A_3–D and the point C is located. An arc is then passed through the three points B, C, and D, the center of which may lie on or above the line A_1–B. The curves VA_1A_3 and fed may or may not be concentric and fed may consist of two curves and a straight line at e. After points d and f are located, dK is drawn horizontally and fg parallel to A_3h. From a point distant H (3/4 to 1 1/2 inches), from the top of the head draw a line tangent to the curve BCD. The stress in the section P–Q will usually be less than the stresses in sections A_3–D,

A_2–C and A_1–B; if much less, the flange thickness at P may be reduced, which will result in lowering point K. Line Kd will then be higher at d than at K.

The frame walls should be braced with diagonal webs as indicated and also tied together in a number of places by ribs produced through having holes made in the cores. The thickness of these ties should about equal the thickness of the walls and their length should equal twice the thickness. A suitable opening must be provided in the lower jaw to allow punchings to escape. Provision must also be made for connecting the clutch mechanism, driving shaft bearings, stripper, gib, backstand, etc. The thickness of the floor flange and bracket should be sufficient to insure a good casting. Some machines have the backstand and frame cast integral.

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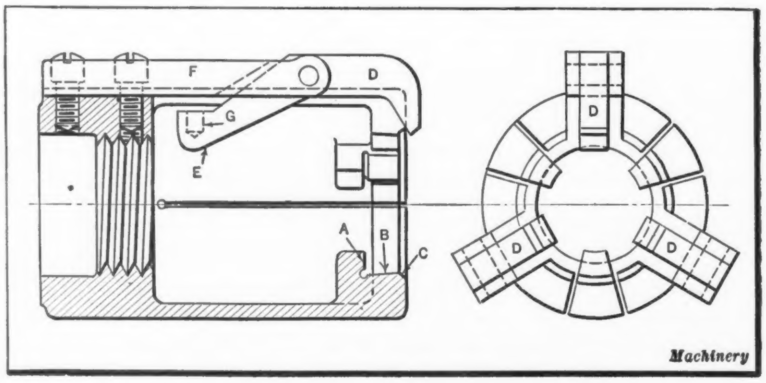


Fig. 3. Split-type Chuck shown at Left in Fig. 1

UNUSUAL GRINDING CHUCK DESIGNS

Two interesting chucks have been developed by the Engineering Department of the Bock Bearing Co., Toledo, Ohio, for holding the cup of the taper spherical-head roller bearings manufactured by this concern, while grinding the taper internal surface around which the rollers rotate.

The tolerance allowed on the nominal diameter of this surface is 0.001 inch, and the surface must not be more than 0.002 inch out of round. Both chucks are illustrated in Fig. 1, the one at the right being the newer and preferable design. The construction of this chuck will be understood by referring to Fig. 2, from which it will be seen that one side of the cup is seated firmly, on three raised finished surfaces of a cast-steel ring A, by means of three fingers B.

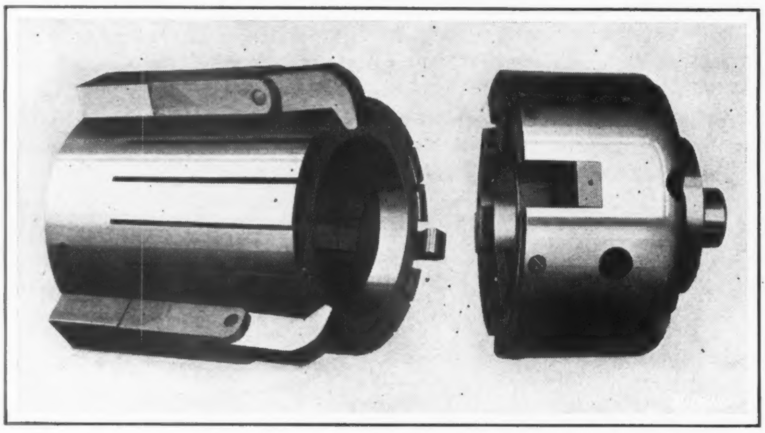


Fig. 1. Two Chucks used for holding the Cup of Bock Bearings in grinding the Internal Taper on the Outer Raceway

These fingers are forced down against the rounded outer corner of the opposite side of the cup when a pull-rod is operated to draw member C away from the front of the chuck. When this movement is transmitted to part C, the outer end of fingers B is forced against the work as mentioned, the slanting surface on top of the fingers being slid horizontally along the tapered internal surface of ring segments D. The action of fingers B is relied upon entirely to centralize the work with the grinding wheel. As part C is again pushed forward to release the work, coil springs in ring A raise the fingers as they are again moved horizontally. The side of the cup that comes in contact with ring A is ground previous to this operation. Coolant is delivered to the work and wheel through tube E, which is contained in the sleeve that actuates part C. Parts A, B, C and D are hardened and ground. The chuck body is an iron casting, threaded to suit the spindle of the machine on which it is used.

In the split type of chuck shown at the left in Fig. 1, the cup is seated both on one side and around its periphery. The side comes in contact with surface A, Fig. 3, of three lugs on the body casting, while the periphery seats on surface B of the split sections. In placing the work in this chuck, it is pressed against beveled edges C to expand the split sections so that the cup can be entered on surfaces B, and the tendency of the split sections to contract seats the cup firmly and aligns it with the grinding wheel spindle.

The cup is held in contact with surfaces A by three fingers D, the front ends of which are swung down on the outer rounded corner of the periphery of the cup when a member not illustrated is pulled back in contact with end E of the fingers. The fingers swivel about a pin bearing at the forward end of blocks F. When the finger-actuating member is again pushed forward, a small coil spring in hole G in each finger causes the finger to swivel so that the outer end is raised, releasing the work. Surfaces B taper ½ degree inward, and this helps to hold the work in place against surfaces A during the movement of the grinding wheel back and forth across the hole in the cup. The slits around the chuck body are 1/16 inch wide.

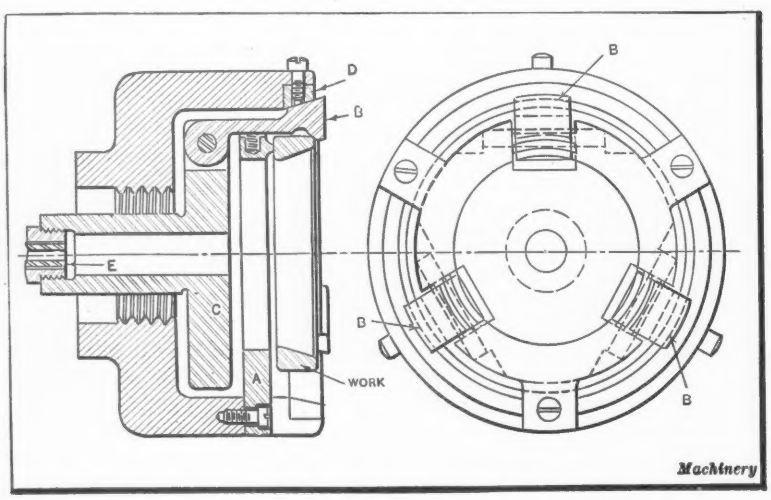


Fig. 2. Construction of Grinding Chuck shown at Right in Fig. 1

* * *

The automobile industry in the United States now consumes 80 per cent of all the rubber imported into this country; 63 per cent of the upholstery leather manufactured here; 40 per cent of the production of plate glass; 22 per cent of the aluminum output; 17 per cent of the output of tin; and 12 per cent of the copper mined.

Grinding the Eyes of Leaf Springs

IN most automobile springs of the leaf type the eyes are formed directly on the ends of the main plate, and it is customary to machine the eyes to width after bushings have been pressed into them. A machine used for this operation is the No. 220 double-disk grinding machine built by the Badger Tool Co., Beloit, Wis. Fig. 1 shows this machine equipped for hand operation, the production averaging 330 springs ground at both ends per hour. This is a high rate of production, considering the tough steel from which these springs are made.

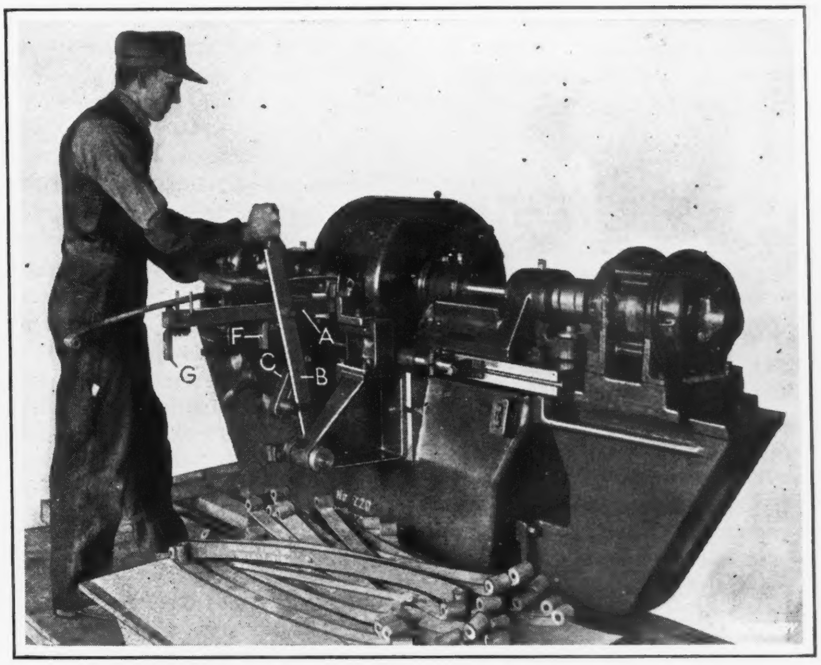


Fig. 1. Double-disk Grinding Machine adapted for finishing the Eye Ends of Leaf Springs

The spring is placed with one end resting in a V-block near the rear end of the reciprocating bar *A*, and is passed back and forth across the faces of the two grinding disks by manipulating lever *B*. In addition to the line contact afforded by the V-block, the spring is located at the front end of the reciprocating bar by means of an adjustable setscrew. This provides a three-point support, and eliminates wabbling of the springs. The action of the grinding disks forces the eye into the V-block, and consequently no clamps are required. The operator bears lightly on the top of the spring to hold the outer end down. Upright fingers and brackets on the reciprocating bar hold the spring parallel with the disk faces. The operation is done dry.

Both wheel-heads of the machine are fed longitudinally along the bed into contact with the work after the eye of the spring has been advanced beyond the periphery of the wheel. The two heads are moved simultaneously by a single spur pinion which operates two racks. In operation, an unground spring is placed on the fixture, and lever *B* is pushed toward the machine until it comes in contact with the rear stop on part *C*. This causes the shaft on which part *C* is mounted to swivel and bring the low surface of cam *D*, Fig. 2, beneath the roller attached to the end of arm *E*. The view Fig. 2 shows a machine in which the operation of the reciprocating bar is automatic and which was equipped for grinding automobile door hinges; however, it will be assumed that the shaft on which cam *D* is mounted is operated as shown in Fig. 1.

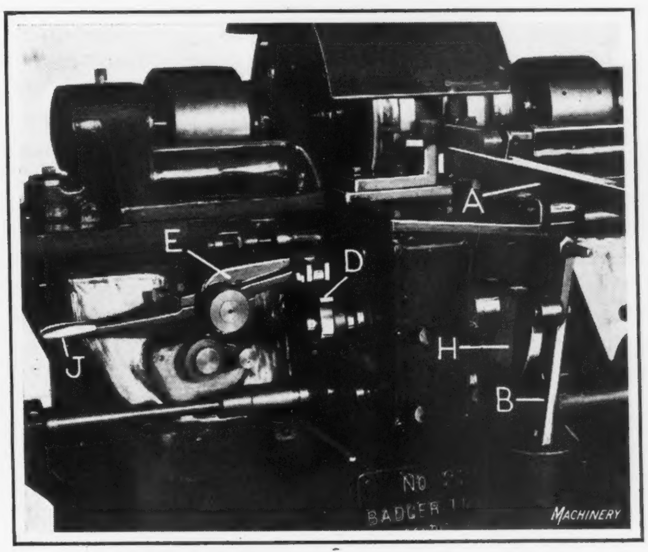


Fig. 2. Grinding Machine in which the Reciprocation of the Work-bar and the Head Movements are Automatic

Weights at the back of the machine cause the shaft carrying arm *E* to swivel so as to hold the roller in contact with the cam. As the pinion operating the head racks is keyed on the same shaft, the heads are fed toward the work when the shaft turns.

As previously mentioned, the heads are not brought together until the eye to be ground is opposite the wheel faces, and so the work does not contact with the edges of the wheels at the beginning of the grinding. The operator pushes lever *B* back and forth several times between the two stops on bar *C* without striking them, until the eye is ground to the desired width. He then pulls the lever hard against the front stop on part *C*, causing this part and the shaft to which it is attached to swivel in the opposite direction to that in which it formerly turned, and thus again bringing the lobe of cam *D* beneath the roller of arm *E*. Obviously, as the arm turns, the pinion again functions, and moves the heads apart, away from the work. However, the heads do not move apart until after the eye has been pulled out from between the wheels, thus insuring a good finish.

Solid abrasive disks are used on the machine, and during the reciprocation of bar *A*, the eye is fed partly past the central hole of the disk to prevent any ridges from being formed on the face. The forward and backward movements of the reciprocating bar are limited by stops *F* and *G*, respectively. The reciprocating bar rests on rollers both at the front and back of the machine and is guided past the disk faces by rollers held in brackets on each side of the bar.

When the operation of the reciprocating bar is automatic, cam *D*, Fig. 2, revolves constantly, and there is a heart cam *H*, mounted on the opposite end of the same shaft instead of member *C*, Fig. 1. Weights hold the roller on lever *B*, Fig. 2, against this cam, with the result that bar *A* is actuated according to the movements that the cam imparts to the roller. The contour of the cam is such that the work is reciprocated twice between the faces of the grinding

disks before withdrawal. With this machine 2500 pairs of malleable iron hinges are produced per nine-hour day, the hinges being held within a tolerance of from 0.003 to 0.004 inch.

In this machine, as originally built, lever *B* was operated manually to oscillate the work, but it was also necessary for the operator to manipulate lever *J*, Fig. 2, in order to feed and withdraw the wheel-heads. When the reciprocation of the work is entirely automatic, the operator need only place work on the carrying bar, and with the mechanism shown in Fig. 1, he is required to manipulate only one lever.

* * *

THE ADVANTAGES OF VOCATIONAL EDUCATION

By W. H. MYERS, Director of Vocational Training, R. K. LeBlond Machine Tool Co., Cincinnati

In view of the shortage of skilled labor in the machine tool industry, many industrial concerns have installed departments for the education of prospective employes along lines that will better fit them for the work they are to do. These departments are called by various names, such as training departments, vestibule schools, apprentice schools, vocational schools, etc., but the majority of them devote their attention solely to mechanical training; a few teach the students arithmetic or some other subject that may be useful in conjunction with their trade. Each company, however, appears to attack the problem from its own individual viewpoint, and students are trained along the lines and to the system that will bring the quickest benefit to the employer, overlooking the fact that the broader the scope of the fundamental training, the less will be the future need for retraining men that have been trained in other plants and by other systems.

The writer believes that the boy graduate of any vocational school should be familiar, as far as possible, with the systems followed in his chosen work, so that no matter where he may be employed he will not need to be taught over again in order to fit him for his particular job. Probably no two concerns in the entire country have exactly the same system or the same way of doing work, but the fact remains that in all concerns engaged in the machine tool industry the systems and methods follow along lines sufficiently related to enable the boy who has received a broad fundamental training to adapt himself quickly to a particular shop.

From the writer's experience as an apprentice in a shop and as a teacher in vocational schools, he believes that the training of the vocational school is far superior to that received in the average shop or factory.

Boys seeking work generally look first in the locality in which they live. They have no way of telling the kind and quality of the work done unless by chance some friend happens to know, and they are as likely to pick out a shop where they do not teach all of the trade as a shop where they do.

Every boy starting out in life is told that he must begin at the bottom which is proper enough, but the bottom does not mean an assistant to a laborer, where the boy sweeps the floor and runs errands for several months. In the average shop, the boy obtains very little knowledge of his chosen work during the first few months, and in some cases even longer. Even after he is started, the work is not laid out in any educational sequence, and he is shifted from one job to another, not at regular stated intervals, but at the whim of the foreman. Then, how many foremen are qualified to teach? Certainly not the average foreman. He, in all probability, holds his job because he can do a certain process a little quicker or better than the average; but *knowing* how is quite different from *teaching* how.

Several big concerns have a regular vocational training department, where the student is taken in hand by competent instructors and taught all the fundamentals before he is allowed to go out into the plant; and when he does go out into the plant, he knows how to operate one or more of the machine tools. In this sort of vocational school the student is taught by an instructor qualified for this work by reason of his shop experience and also by his experience as a teacher. The work is arranged in an educational sequence, and each step is explained in turn and the reason for it made clear in school-room talks and demonstrations.

The student is taught how to draw, and how to figure his job. He is taught English, both written and oral. The history of his trade is taught, so that he may have some appreciation of the struggle of the early artisans to advance the art of invention and manufacturing. He also learns the history of his Government and the duties of a citizen, as it is just as important for an apprentice to be a good citizen as a good mechanic. Labor unrest and disturbances are caused in a great many instances by a lack of understanding of our institutions. It goes without saying that such instruction makes a better citizen and artisan, for the boy has been taught not only to make a living, but also how to live. He will make a better balanced man and one who will not be easily led astray by agitators.

In view of the facts mentioned in the foregoing, the writer sometimes wonders why it is that employers everywhere do not take a greater interest in establishing vocational schools for the education of their future employes. The whole principle of vocational education and the many advantages accruing from a properly conducted vocational school in a manufacturing plant may be designated as the "giving and getting plan," and is embodied in the following few sentences:

The employer gives the opportunity for training, thereby getting the loyalty of the employe and securing a good investment.

The employe gets an opportunity to develop, by giving intelligent effort, quality, and accuracy.

The result is satisfaction of both parties.

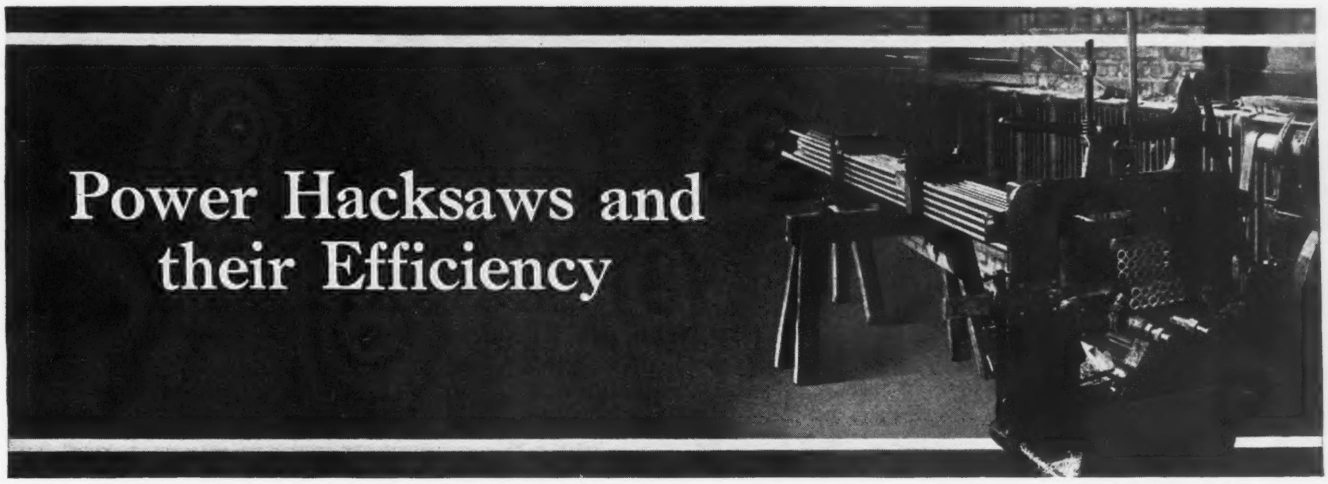
* * *

PATENT INSURANCE

What seems to be a practicable and desirable change in our present patent system has been proposed by Professor Thomas A. Hill, counselor at patent law, New York City. Mr. Hill advocates the legalization of patent insurance so that the manufacturer, dealer, inventor, or investor, can, by payment of suitable premiums, procure a policy of insurance against infringement. This would protect the patentee or producer against infringement of his patent rights by others, and insure him against loss resulting from unintentional infringement of the patent rights of others in the manufacture of his own patented products. Such an insurance company would naturally refuse policies on many patents, and the public might do well to avoid investment in such patents. Also, the insured patents would prove to be much safer and more attractive investments, and meritorious inventions would thus find available markets without the sacrifices now necessary.

* * *

Australia is today, as it has been for some time past, the leading export market for American automobiles. The value of the cars exported to Australia in 1922 was $23,000,000. In addition, considerable exports were made from Canada by American manufacturers having Canadian branches. Forty per cent of the entire exports of the country were represented by eight of the best known makes of American cars.



Power Hacksaws and their Efficiency

By H. J. SWANSON, General Sales Manager, Peerless Machine Co., Racine, Wis.

THE power hacksaw machine, in its simplest form, merely provided means for reciprocating an ordinary hand hacksaw frame by mechanical power. Gradually, a great many improvements have been made in these machines, until today they constitute a distinct type in the machine tool class.

The first improvement made in machines of this kind was to apply weights to give an adequate cutting pressure to the saw blade. The weight of the saw frame, in addition to sliding weights, is today utilized in several power hacksaw machines for obtaining varying pressures on the blade. One of the builders of machines of this type states that by increasing the pressure on the blade from 44 to 92 pounds in sawing off machine-steel bars 2 inches square, it is possible to maintain, with the same saw, a sawing time of six minutes on each piece, which will not vary more than one minute either way, in sawing up as many as 170 pieces with one blade. This means that one blade, sawing at the rate of 40 square inches per hour lasts through 680 square inches of cross-section, which is a remarkable performance from the point of view of blade economy. Of course this machine lifts the blade on the return stroke, and an air cylinder, acting as a dashpot, prevents the head from falling rapidly at any time.

Another power hacksaw machine, well known in the market for several years, employs a ratchet feed. A ratchet similar to a gear rack is fastened to the saw-blade frame-head. Two sets of dogs or ratchet fingers force the rack down at each cutting stroke. A coiled spring causes the ratchet fingers to pull the rack down constantly, through an arrangement that permits one set of fingers to be in contact while the other set is transferred to another notch in the rack. With this machine a blade will last from six to eight hours, sawing mild steel at the rate of from 50 to 90 square inches per hour.

The blade pressure is varied by changing the compression of the spring that supplies the power for the ratchet fingers, this change being made through a lever on the side of the machine. In this type of machine one or more coiled springs are arranged on levers so that the weight of the head of the machine is balanced. The feed mechanism supplies all the pressure, and when the feed is disengaged, the head is automatically lifted. This removes the risk of the head falling in the event of blade breakage or the disengagement of the feed, and thereby causing damage to the work or injury to the operator. On the return stroke, the head is lifted slightly to relieve the pressure on the blade.

In still another power hacksaw machine the pressure on the blade is supplied by the weight of the head, a sliding weight being used to increase or decrease the pressure. To prevent the head from falling on the non-cutting stroke, an arc-shaped ratchet or rack is used, and two ratchet fingers which receive their motion from the crank, regulate the lifting of the head on each return stroke to relieve the pressure on the blade.

A somewhat different arrangement is used by another builder of power hacksaw machines. Here the blade pressure is applied mainly from an oil cylinder, the pressure in which is produced by a pump. In this machine, the cylinder regulates the speed with which the head approaches the work, as well as the pressure. It can also be used for holding the head in its uppermost position when changing the work in the vise, by means of a simple valve control lever. At the Foundrymen's convention held in Cleveland this year, it was demonstrated that this type of machine would cut off shafting at the rate of 1.37 square inches per minute or about 82 square inches per hour. The manufacturer stated that only one saw blade was used per day during the exhibition.

In a fifth type of machine the saw frame does not travel downward through an arc, but instead is mounted on a double-bearing slide, so that the blade always travels along parallel lines. The saw frame is brought down by means of a screw and nut mechanism actuated intermittently by a ratchet and pawl. Between the ratchet and the screw is located a friction disk that prevents excessive pressure from being exerted on the blade.

Types of Saw Blades

The straight-tooth blade is generally preferred for power hacksaw machines, although hacksaw blades are made with hook teeth and other variations having positive and negative rake. The objection to the hook-tooth blades is that they "hog in" or bury their teeth whenever they come in contact with edges or walls of the work having an acute angle. Blades having negative rake teeth require more pressure in cutting, but they are often of advantage for cutting parts having thin walls, and in general for work that presents little or no resistance to the pressure of the teeth.

The most commonly used pitches are 10 and 14. The 10-pitch blades are used to cut heavy cross-sections, while the 14-pitch blades are used for medium and light work. On the extremely hard materials of small cross-section, where a heavy pressure must be applied, a fine-pitch blade is necessary, so that the pressure can be distributed over enough teeth to prevent the points of the teeth from crumbling under the pressure. On the other hand, in soft metals, blades of a coarser pitch provide chip space for the larger and heavier chips that a heavy-blade pressure produces in the softer metals.

Generally speaking, saw blades are inexpensive tools. A power hacksaw blade 8 inches in length can be purchased

for 5 cents; while a 24-inch blade, 1½ inches wide, costs about 50 cents. The common 14-inch blade, 1-inch wide, costs about 14 cents, and will often last twelve hours on general work.

While it is true that saw blades are comparatively cheap, the fact remains that all machines can exert pressure enough to break the blade, and the object in the design of machines of this type during the last few years has been to incorporate some yielding member or mechanism in the feed arrangement to reduce blade breakage. The sawing performance depends mainly on three factors—the right selection of blades, the use of the proper cutting lubricant, and the application of the right pressure. When the subject is carefully analyzed, it will be found that the length of life of the saw depends largely on the lubricant and the pressure.

Cutting Speeds

The same rules that are used in selecting cutting speeds in a lathe or drilling machine are applicable to the selection of the stroke speeds for a hacksaw. As the cutting action is not continuous and the speed is not uniform, an analysis must be made in order to determine the average cutting speed in a power hacksaw machine. Approximately, the cutting speed of the first and last quarters of the stroke may be assumed to be one-half the speed of the stroke in the second and third quarters. For example, assume that the hacksaw has a 6-inch stroke. Then the first 1½ inches of blade travel is accomplished at half the speed of the next 1½ inches of travel, which completes half the stroke. The third 1½ inches of blade travel is accomplished at the same speed as the second, and finally the fourth and last 1½ inches of travel is again accomplished at one-half the speed of the two middle fourths; or briefly, the middle 3 inches of the stroke is traveled at an average speed of twice that of the ends, and this is the cutting speed to be reckoned with.

To illustrate exactly what the cutting speed is, lay out a half circle, and connect each end of the half circle by its diameter. Divide the arc of the half circle into three equal spaces. Project the division points down to the diameter, and it will be seen that the length of the middle space, measured on the diameter, is twice the length of the end spaces.

In other words, we have a graphic illustration of the cutting stroke, and it will be seen that the two middle fourths of the stroke are traveled in one-third of the half-circle or in one-sixth of the time required for one complete revolution of the crankshaft. Hence, if the saw blade continued to travel at the same cutting speed as it does during the middle three inches of the stroke for an entire revolution of the crankshaft, it would travel six times three inches, or eighteen inches per revolution.

From this we obtain the cutting speed in feet per minute as equal to R. P. M. of crankshaft $\times \dfrac{6 \times 3}{12}$. For example if the crankshaft is running at 100 revolutions per minute, and the stroke is 6 inches, the cutting speed would be 150 feet per minute; at 80 revolutions per minute, it would

TABLE 1. CUTTING SPEEDS FOR POWER HACKSAW MACHINES—6-INCH STROKE

(S. P. M. = Cutting Strokes Per Minute)

Material to be Cut	Composition, Per Cent					Cutting Speed, in Feet Per Minute	R. P. M. of Crankshaft, or S. P. M.
	Carbon	Tungsten	Nickel	Chromium	Manganese		
Cold-rolled steel	Less than 0.13					160 to 190	105 to 125
Machine steel	0.08 to 0.13					175 to 200	115 to 135
Screw stock	0.11 to 0.14					150 to 175	100 to 115
S.A.E.1020,1114,etc.						150 to 175	100 to 115
Medium carbon steels	0.20					130 to 160	85 to 105
	0.30					125 to 155	80 to 100
	0.40					120 to 150	80 to 100
	0.50					115 to 145	75 to 95
	0.60					110 to 140	75 to 95
	0.70					105 to 135	70 to 90
Tool steels	0.80					100 to 120	65 to 80
	0.90					95 to 115	60 to 75
	1.00					90 to 110	60 to 75
	1.10					85 to 105	55 to 65
	1.20					80 to 100	50 to 60
High-speed steel	0.50 to 1.00	0.05 to 0.15				70 to 85	45 to 55
	1.00 to 1.50	0.10 to 0.20				65 to 80	40 to 50
	1.50 to 2.00	0.15 to 0.25				60 to 75	40 to 50
Nickel steels	0.10 to 0.20		3.25 to 3.75			110 to 130	75 to 85
	0.20 to 0.30		3.25 to 3.75			100 to 120	65 to 80
	0.30 to 0.40		3.25 to 3.75			90 to 110	60 to 75
	0.40 to 0.50		3.25 to 3.75			80 to 100	55 to 65
Low nickel-chromium steels	0.10 to 0.20		1.00 to 1.50	0.30 to 0.75		125 to 145	80 to 95
	0.20 to 0.30		1.00 to 1.50	0.30 to 0.75		120 to 140	80 to 95
	0.30 to 0.40		1.00 to 1.50	0.30 to 0.75		115 to 135	75 to 90
	0.40 to 0.50		1.00 to 1.50	0.30 to 0.75		110 to 130	75 to 90
Medium nickel-chromium steels	0.10 to 0.20		1.50 to 2.00	0.75 to 1.25		80 to 95	55 to 65
	0.20 to 0.30		1.50 to 2.00	0.75 to 1.25		75 to 90	50 to 60
	0.30 to 0.40		1.50 to 2.00	0.75 to 1.25		70 to 85	45 to 55
	0.40 to 0.50		1.50 to 2.00	0.75 to 1.25		65 to 80	40 to 50
High nickel-chromium steels	0.10 to 0.20		3.25 to 3.75	1.25 to 1.75		50 to 60	35 to 40
	0.20 to 0.30		3.25 to 3.75	1.25 to 1.75		45 to 55	35 to 40
	0.30 to 0.40		3.25 to 3.75	1.25 to 1.75		40 to 50	30 to 35
	0.40 to 0.50		3.25 to 3.75	1.25 to 1.75		35 to 45	30 to 35
Manganese steels	0.80 to 1.25				0.10 to 0.25	80 to 100	55 to 65
Cast iron (cut dry)						75 to 100	50 to 65

Machinery

be 120 feet per minute; and at 50 revolutions per minute, 75 feet per minute.

From the foregoing it is evident that when a given cutting speed in feet is required on a machine having a 6-inch stroke it is only necessary to see that the revolutions per minute of the crankshaft or the cutting strokes per minute (abbreviated S.P.M.) equal two-thirds of the cutting speed expressed in feet. Assume that for a given case a cutting speed of 90 feet would be satisfactory, when using a cutting lubricant. Then the S.P.M. with a 6-inch stroke should be 60.

If the intermittent cutting speed produced by the crank movement will permit higher cutting speeds than those recommended for turning steel, it is only necessary to assume a certain percentage of increase over the recognized cutting speed for lathe tools. Table 1 has been worked up by taking into consideration the quick-return stroke on most power hacksaw machines, and also the fact that the cutting speed is approached only during one-sixth of each complete stroke. The cutting speeds are entirely feasible because the qualities found in saw blade steel are similar to those of high-speed steel.

Saw Blades for Different Kinds of Service

One of the leading manufacturers of hacksaw blades states that tests have determined that the best steel for saw blades should contain from 1.00 to 1.25 per cent carbon, 0.55 to 2.00 per cent tungsten, 0.20 to 0.50 per cent manganese, 0.20 to 0.80 per cent chromium, and about 0.25 per cent vanadium. Another well-known manufacturer of saw blades keeps the carbon content between 0.80 and 0.90 per cent, but increases the tungsten content from 2.00 to 3.60 per cent, thereby obtaining what is claimed to be an unusually tough and hard blade. The high carbon content blades are not so suitable for high tension as the medium carbon blades; but they are often found to cut better under medium pressures and high cutting speeds, while the lower carbon content blades often cut best on materials that call for a heavy feed or pressure, but a medium or low cutting speed.

The writer recommends high carbon blades for mild steel, where high speed and medium pressure is used, and the lower carbon blades with higher tungsten content for alloy steels, where medium cutting speed and heavy pressures are used. If a great deal of sawing is done in one class of steel, the highest feasible cutting speed may be determined as follows: Increase the S.P.M. by 5 for each piece cut off until the temper is drawn in the blade in spite of the cooling lubricant. Then reduce the S.P.M. about ten strokes, and the most efficient cutting speed has been obtained.

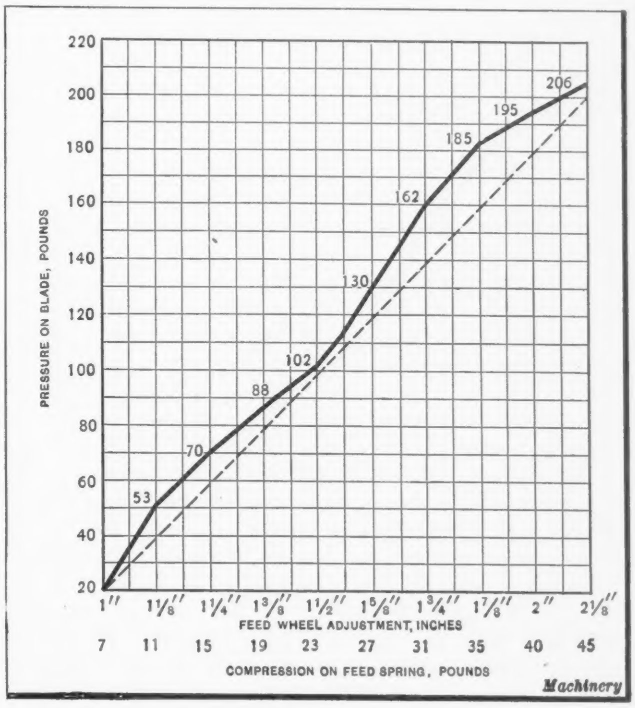
Feeds or Pressures on the Blade

After the cutting speed has been determined, the question of blade pressure arises. The question is often asked: "How much pressure can the blade stand?" Generally speaking, the blade can stand any pressure up to the point where it begins to break, but this breaking point is not always due to a given pressure; it depends upon the condition of the saw. The average 14-inch saw blade, 1 inch wide, and 16 or 18 gage (0.065 and 0.049 inch thick, respectively) will stand a 50-pound pressure when new. But when the corners of the teeth are worn so that the side clearance on the tooth sides is gone, then the teeth are forced into a wedge-shaped opening that places an excessive upward strain on the blades, as well as greater tension. This thrust and tension are the real causes of blade breakage, and these forces are far in excess of the 50-pound weight placed on the blade. The question, therefore, should be: "How much tension can a blade stand?"

The company with which the writer is connected has investigated the relationship between blade pressure and tension, and in one of its latest machines, more tension has been put on the blade than formerly, by the development of a new type of saw frame. Tests at the factory have shown repeatedly that a 10,000-pound tension can be put on a blade by this construction. The value of this tension is that greater thrust can now safely be taken by the blade. In the tests made to substantiate these statements, a spring scale was placed above the machine directly over the work position, and also above the feed mechanism, so as to register accurately the pressure that the feed mechanism placed on the saw frame.

The accompanying illustration, based on the experiments made, shows that with the arrangement in the machine referred to, when the feed spring produces a pressure of 7 pounds, the blade is under 20 pounds pressure; when the feed spring produces an 11-pound pressure, the blade is under a 40-pound pressure; and when the feed spring is under a 45-pound pressure, the blade is under a 200-pound pressure. (See the dotted line.)

It will be seen that the increased tension on the blade results in faster cutting, simply because the blade can stand



Relation between Pressure on Saw Blade and Compression on Feed Spring

more pressure without breaking; whereas, in the older types of machines, it was not safe to put much more than 100 pounds pressure on the blade. The present type of machine permits a pressure of 200 pounds. The feed-wheel adjustment given in inches on the chart brings corresponding pressures on the blade, as shown.

In the tests, the feed-screw was set at ⅛ inch intervals, and the resulting pressure was measured by the weighing scale fastened to the saw frame, the readings being shown by the full line. The breaks in the full line are the result of a binding action in the downward movement of the saw frame, and when this binding action is disregarded, the pressure comes very close to the theoretical dotted line. At any rate, the chart shows that the pressure varies quite regularly with regular movements of the feed-wheel.

Pressure alone, however, does not determine sawing time, because a hard steel may need heavier blade pressure, or the cross-section may be such as to limit the amount of pressure. Then, again, when the blade becomes dull, more pressure must be added if the same cutting time is to be maintained. Table 2 shows the effect of increasing the pressure as the blade becomes duller. It also shows how the sawing time increases if the pressure is not correspondingly increased as the blade becomes dull.

Determining Time Required for Sawing

How, then, is the sawing time generally to be determined? First, by how much time one is willing to take for the sawing off; second, by how great a blade expense is considered warranted; and third, by the size, shape, and hardness of the work. When time is not a factor, the slower the work is done the longer the blade will last, and blade expense is decreased. On the other hand, if the job is wanted quickly and money can be saved by fast sawing, the blade expense incident thereto may be negligible. One of the tests previously referred to indicated that by sawing only at the rate of 40 square inches per hour, the blade was made to last 17 hours. This procedure is well to follow if blade expense is the first consideration.

TABLE 2. RESULTS OF EXPERIMENTS SHOWING RELATION BETWEEN PRESSURE ON SAW BLADE, SHARPNESS OF SAW, AND CUTTING TIME

Size of Stock being Cut, Inches	Material	Cutting Strokes per Minute	Pressure on Blade, Pounds	Cutting Time, Min. Sec.	Rate of Cutting per Hour, Square Inches
2 × 2 (1)	Mild Steel	130	100	2 – 25	99
			100	2 – 22	102
			100	2 – 26	98
			100	2 – 26	98
			100	2 – 32	95
			100	2 – 32	95
			140	2 – 9	111
			160	1 – 59	121
			160	1 – 59	121
			160	1 – 59	121
			160	2 – 1	119
			160	2 – 1	119
			160	2 – 1	119
			180	1 – 45	137
			180	1 – 45	137
3 × 3 (2)	Mild Steel	130	20	11 – 50	45
			40	11 – 4	48
			60	10 – 28	51
			80	9 – 24	57
			100	8 – 52	61
			120	7 – 48	69
			140	7 – 30	72
			160	7 – 22	73
			160	7 – 19	73
			180	6 – 45	80
2 × 2 (3)	Mild Steel	130	20	3 – 49	63
			40	2 – 42	89
			60	2 – 21	102
			80	2 – 13	108
			100	2 – 1	119
			120*	2 – 6	114
			140	1 – 51	130
			160	1 – 45	137
			180	1 – 36	150
			200	1 – 35	152
6 × 6 (4)	Alloy Steel 0.70 Carbon	85	150	36 – 0	60
			150	34 – 3	60
			150	35 – 11	61
			160	34 – 1	60
			160	34 – 16	60
			180	36 – 17	59
2 × 6 (5)	Tool Steel 1.10 Carbon	85	140	12 – 27	58
			160	11 – 22	63
			150	11 – 43	61
			150	12 – 29	58
			150	12 – 33	58
			150	12 – 25	58
			150	12 – 27	58
			150	12 – 41	57
			150	12 – 36	57
			150	12 – 39	57

Machinery

(1) The object of this test was to maintain approximately an average sawing time. It will be noticed that the saw is sharpest on the second cut. The total time for 15 cuts was 32 minutes 22 seconds, or an average per cut of 2 minutes 10 seconds. The saw blade used for this and all the following experiments was 18 gage, 14 inches long, 1 inch wide, 10 pitch.

(2) This example will be of value in selecting the right pressure when a given sawing time is required.

(3) In this test the pressure was increased 20 pounds for each cut, and the time noted.

(4) The steel cut was very tough, a cooling lubricant consisting of three gallons of screw cutting oil and one pound of sulphur was used. The blade was dull after it had finished the last cut.

(5) The steel was placed flat in a vise. When the steel was placed edgewise, the sawing time was increased 25 per cent, since only 2 inches of teeth could work at one time. The steel was well annealed and the saw blade made 85 cutting strokes per minute.

*The blade encountered a hard spot and slowed up as it went through the work.

On the other hand, when speed is important, pressure should be applied that will wear out the blade every two or three hours. In the machine referred to, recently brought out by the company with which the writer is connected, three cutting speeds of 75, 125, and 200 feet per hour result, respectively, in the saw going through 60, 80, and 120 square inches per hour, in mild steel.

Then, again, pressure alone does not determine sawing time, because while one may use a 200-pound pressure on either mild steel, alloy steel, or tool steel, each of these three steels requires different cutting speeds, and for that reason the sawing time will be different. Generally speaking for fast cutting the sawing time should be maintained within a small limit, as, for example, within seven or eight minutes on a job that requires cutting off eight pieces per hour. The pressure should be set to about four-fifths of the total pressure capacity of the machine, and when the sawing time shows a tendency to increase, the pressure should be increased to reduce the time.

After all, judgment and common sense must decide the best procedure. If production can be doubled by wearing out blades at the rate of one per hour, it may be good judgment to do this. If, on the other hand, by using a reduced pressure the work can be cut off so close to length that it can be directly ground on the ends, and does not need a semi-finishing cut in the lathe or milling machine, then reduced pressure and consequent reduced speed in the cutting off process may be economical.

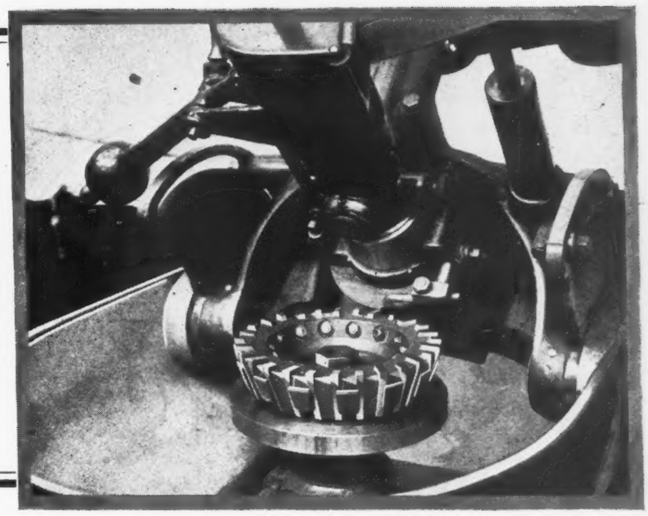
The whole problem of machining a part must be considered in connection with the work of the power hacksaw machine, and by studying all the details of the problem it is possible to determine upon the most economical methods of operating the machine. A large shop recently spent several thousand dollars in machining forgings that came to the lathes with a great deal of material to remove from the ends. A good power hacksaw would have reduced this expenditure greatly. The improvements that have been made in machines of this type have placed them in the machine tool class, and the wise executive will do well to review the possibilities offered by modern machines for sawing off stock and cutting it to length. The cost of operation is low, and with proper usage, the cost of saw blades is not heavy.

* * *

ALUMINUM PISTON ALLOYS

The two chief difficulties in producing suitable aluminum alloy pistons have been, first, to obtain an alloy that would meet all the requirements of an automobile engine piston and, second, to so design the piston as to meet the special qualities of the metal and the needs of the service. The alloy must, of course, resist such shocks as are met with in internal combustion engines and at the same time must have a high thermal conductivity. The coefficent of thermal expansion must be similar to that of cast iron. The National Physical Laboratory advocates an aluminum alloy consisting of 4 per cent of copper, 2 per cent of nickel, and 1.5 per cent of manganese, the remainder being aluminum. This material, when cast in 1-inch diameter chill-cast bars, has an ultimate strength, at 250 degrees C. (482 degrees F.), of about 25,000 pounds per square inch. Experiments have shown, says *The Metal Industry*, that the clearance of aluminum pistons should be about 50 per cent greater than that necessary for cast-iron pistons.

Grinding and Inspecting Stellite Cutters



Methods Employed to Obtain Accurately Ground Stellite Cutters of the Inserted-tooth Type

By C. W. METZGER
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In April MACHINERY, page 589, and in May MACHINERY, page 717, there appeared articles on the use of stellite milling cutters. It was the object of these articles to show the designs of stellite cutters that have proved best adapted for cutting different metals and to instruct the readers as to how they should be employed to give maximum efficiency. In the present article, the methods employed to insure accuracy in grinding and inspecting the cutters are dealt with.

In the first place it is essential that the cutter grinding machine be properly adjusted and kept in the best possible condition. All of the grinding machine bearings and members that are subject to wear should be inspected periodically. The following instructions were prepared especially for the purpose of insuring a thorough inspection of a certain make of cutter grinder, but they are equally applicable to any grinder that is likely to be employed.

Rules for Inspecting Cutter Grinders

1. Make sure that the spindle thrust bearings are so adjusted that there is no end play.
2. See that there is no side play in the spindle bearings.
3. If the grinder is of the sliding spindle type, see that the spindle slides freely and that there is no lost motion when the wheel is passing over the cutter blade.
4. See that the machine is equipped with a round-nosed stop or finger-rest which can be adjusted to guide the cutter blades directly under the cutting point of the wheel.
5. Adjust the stop supports so that they are rigid and have no side play.
6. See that the driving belt is adjusted properly and that the laced joints, if any, run smoothly over the spindle pulley.
7. The face of the table spindle on which the cutter is located must run true. Use an indicator to test its accuracy.
8. See that the spindle arbor is loose enough in the bore of the cutter to allow the cutter to be squared up by the face of the spindle.
9. Make sure that the table spindle has no side play or end play in the taper bearing.
10. See that the back of the cutter is kept square with the bore and free from burrs.
11. Make sure that the face of the spindle and the back of the cutter are free from dirt before placing the cutter on the spindle.
12. If a washer is used on the arbor under the clamping nut, be sure that it is of uniform thickness in order to prevent the cutter from being thrown out of true when the nut is tightened.
13. See that a grinding wheel of the right grain and grade is used.
14. Make sure that the wheel is properly trued up or dressed.
15. See that the cutter has as little overhang as possible.
16. Leave the finger-rest set under the cutter blade while indicating the cutter.
17. Make sure that the feeding mechanism of the grinder table is not packed with fine emery dust and oil, as this will sometimes raise the table and thus cause it to run unevenly.

Replacements or adjustments should be promptly made to correct any lack of proper adjustment which may be revealed by the inspection outlined. Periodical inspection and adjustment of a cutter grinder will not only result in more accurate work but will also prolong the useful life of the grinding machine. In addition to following the rules given for inspecting the grinding machine, it is also a good plan to occasionally indicate a cutter after it is mounted on the milling machine arbor. If the milling machine arbor or the face of the arbor or spindle is worn so that the arbor does not run true, the cutter will, of course, run out also.

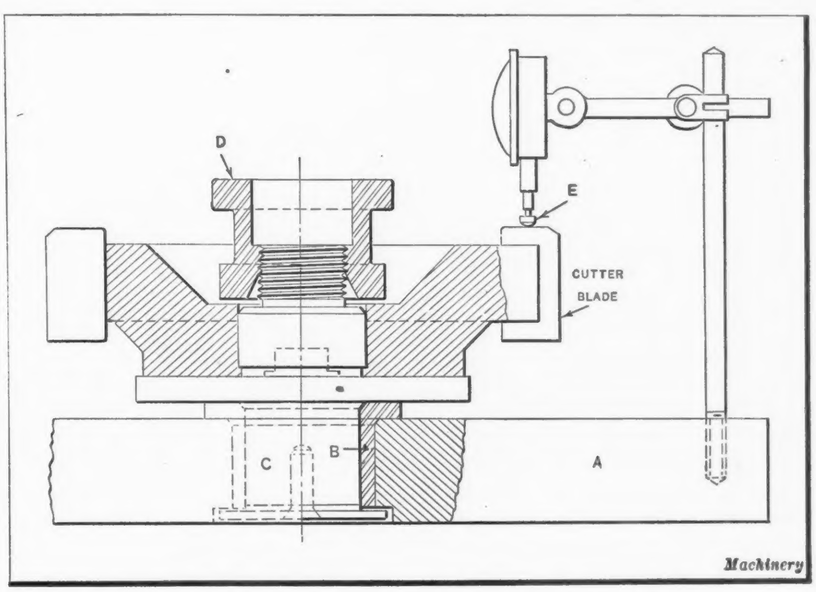


Fig. 1. Fixture for testing Cutter Blades for Uniform Height

When indicating milling cutters after they are ground, the cutter may be left on the grinding machine with the stop set in the same position as when grinding the cutter. The ball point of the indicator should be located on the edge of the blade while the latter is resting on the spring stop. By indicating the cutter in this manner the edge of each blade will be located at the same place on the ball point.

It should be remembered that if

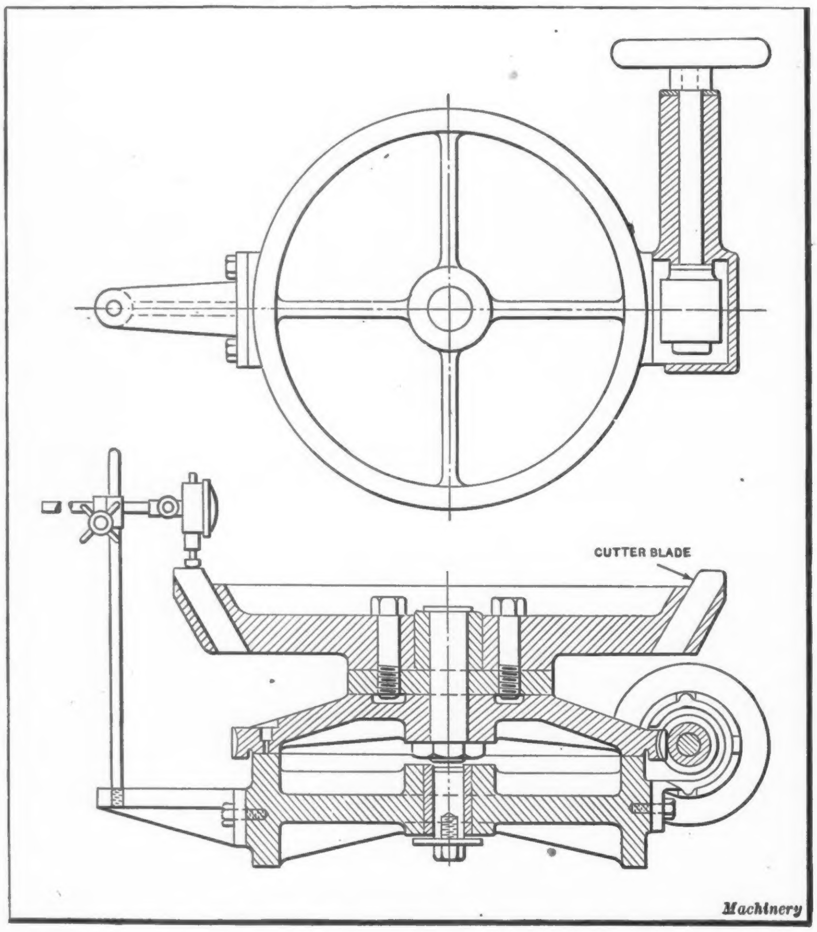


Fig. 2. Cutter-testing Fixture with Worm and Worm-wheel for rotating Cutter Body

there is any end play in the grinder spindle, the wheel will be pushed back from the cutter blade and as a result leave an uneven surface on the cutting face. This will, in some cases, leave the point and heel of the blade low, and the center high. Side play in the grinder spindle will cause the wheel to leave a rough, choppy finish on the cutting edge of the blade which is very detrimental to the cutting life of the tool. Any play in the ways of the grinder table will allow the cutter to be pushed back so that the blades will be ground to different heights.

Inspection Fixtures for Stellite Cutters

The use of inspection fixtures such as shown in the accompanying illustrations have resulted in cutting down expenses, and the inspection departments invariably report a higher quality of work after the adoption of fixtures of this kind.

It may be of interest to note here that a certain inserted-tooth milling cutter 11 inches in diameter (when milling cast iron or semi-steel) was required to be ground approximately 128 times before it was necessary to replace the blades. Figuring the maximum cost at 35 cents per grind, we have a total expense of $50 for grinding during the life of the blades. The cost of grinding will in many cases exceed the first cost of the cutter or the cutter blades. This fact should emphasize the necessity for careful inspection of the cutters before they are allowed to leave the grinder. Cutters which have a few high teeth that will do all the cutting are frequently sent to the shop. This reduces the efficiency of the cutter, and if the few high blades were removed, the cutter would need to be reground less frequently.

When the operator stops his machine to inspect the cutters, the cutter-spindle will generally cease rotating at a point where the highest or dull teeth are in contact with the work, owing to the braking power exerted by these teeth. The teeth that are then in a position to be inspected by the operator are the ones that have been doing no cutting and are therefore sharp. The operator may thus erroneously conclude that the cutter does not need resharpening. When the machine is started up, the dull teeth are often broken out and the cutter body damaged. Thus it will be apparent that accurate and rapid production at less cost, together with increased durability of the milling cutters, unquestionably demands correct cutter inspection and grinding methods.

In Fig. 1 is shown a simple fixture for inspecting face milling cutters having inserted stellite blades. This fixture has a cast-iron base *A*. The bushing *B* is a press fit in base *A* and forms a bearing for spindle *C* on which the cutter is mounted while it is being tested. The back face of the cutter body or hub rests on a flange on spindle *C*. The upper end of the spindle above the flange is similar to the end of the milling machine spindle on which the cutter is to be used except that a knurled nut *D* is used to clamp the cutter in place. When the cutter is properly mounted on the fixture it can be revolved so that the teeth may be successively brought under the indicator point *E*. The indicator will read exactly the same for each blade when the cutter is properly ground.

In Fig. 2 is shown another fixture for inspecting milling cutters. This fixture has a worm and worm-wheel mechanism which provides for rotating the cutter so that the teeth may be successively brought under the contact point of the indicator. The construction of this fixture will be clearly understood by reference to the illustration and no further explanation should be necessary.

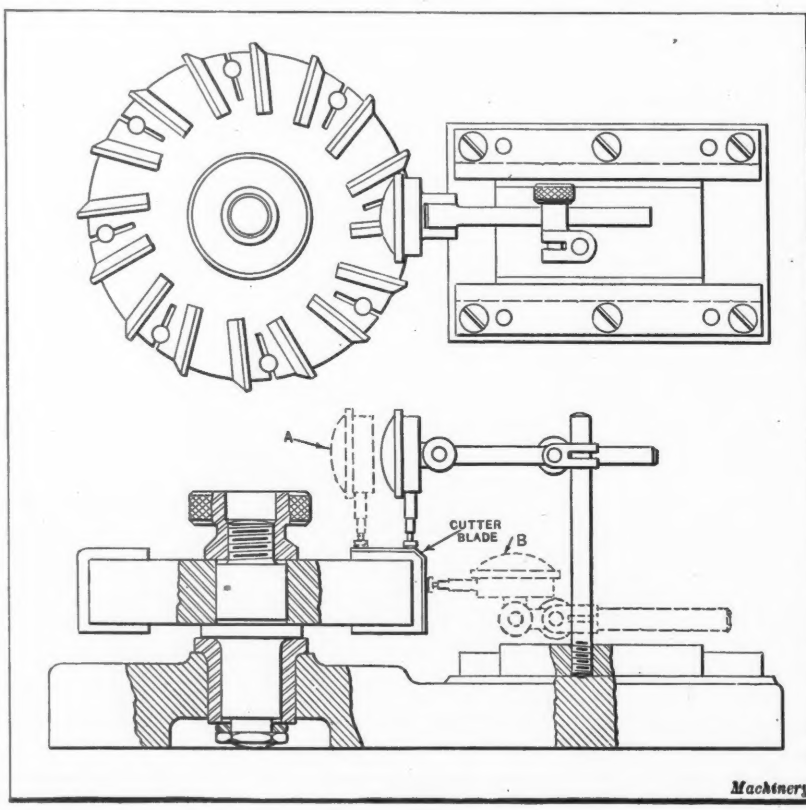


Fig. 3. Cutter-testing Fixture with Adjustable Post for Indicator

Still another fixture for inspecting milling cutters is shown in Fig. 3. It will be noted that the cutter is mounted on a spindle similar to the one shown in Fig. 1. The special feature of this fixture is the slide on which the indicator post is mounted. This slide enables the inspector to move the indicator forward until it occupies the position indicated by the dotted lines at *A*. The dotted lines at *B* show the position in which the indicator is set when inspecting or testing the outer edges of the cutter. By the use of inspection fixtures such as here described, it is possible to detect quickly any inequality in the heights of the teeth, and thus prevent sending cutters back to the shop which are not properly ground.

* * *

QUESTIONABLE FOREIGN EXHIBITS

Several complaints have been received recently by the Department of Commerce at Washington, from American firms who have been induced to exhibit in foreign exhibitions and fairs of doubtful standing. In some cases the American concerns contributed, but actually did not send exhibits over, while in other instances they advertised their products at these exhibitions. In every case it cost them money and did not bring in the proper return.

The Bureau of Foreign and Domestic Commerce keeps accurate data on reliable fairs and exhibitions held all over the world. Before investing money by participation, it is highly advisable for the prospective exhibitor to get in touch with this bureau. Information is received there not only from representatives of the Government of the United States abroad, but also from the local officials of the foreign governments themselves, who are just as anxious to promote their own legitimate fairs and exhibitions as they are to suppress those that are not properly accredited and are without lawful support.

Any concern should be wary of an exhibition promising rewards, and in all cases it is preferable to be informed in advance rather than to discover too late that one has invested good money in an exhibition not indorsed by reliable agencies in the country in which it is held.

* * *

MACHINE BUILDING IN FRANCE

France has never occupied a place of great importance as a machinery producing country for foreign markets, although it has always sold a fair amount of industrial machinery abroad. In a summary prepared by the Department of Commerce, Washington, D. C., it is pointed out that before the war, French exports of industrial machinery varied from 4.5 to 6.6 per cent of the total international machinery trade of the world. In 1919 this percentage was raised to 8.9, but in 1920 and 1921 it fell to about 5.5 per cent. The imports of machinery into France have always exceeded the exports. The tonnage imported in 1920 was about 70 per cent in excess of that imported in 1913, but in 1921 this fell to only 10 per cent above the 1913 tonnage, and in 1922 the tonnage imported was over 15 per cent less than in 1913. The exports of machine tools from France increased from 17,000,000 pounds in 1910 to 19,335,000 pounds in 1920, the latter year showing the greatest volume on record.

* * *

RAILWAY ELECTRIFICATION PROJECTS

A Polish-British Co. has been formed for constructing electric railways in Poland, and it is stated in *Commerce Reports* that a line will first be built from Warsaw to nearby cities, the electric power being furnished by hydro-electric power plants. In Sweden, railway electrification of considerable magnitude is being undertaken, the entire line connecting Stockholm and Gothenburg—the two largest cities in the country—being electrified. The distance is approximately 300 miles.

JACKS FOR THE ERECTING FLOOR

By JOE V. ROMIG

In assembling heavy machinery it is necessary that each piece be leveled up before it is secured in place. As the plumb line and level are often employed to align the shafting, gears, etc., the base casting must first be so adjusted as to be perfectly level. Wood makes a poor blocking for supporting the base in the required level position, channels and I-beams being much better for this purpose. Iron box parallels are also used where available, but all these means of supporting the work have been found to be more or less unsatisfactory.

Where the work of assembling only one product is considered, it has been found profitable to install erecting jacks, such as described and illustrated in this article. Instead of blocks or hollow box parallels, the adjustable floor jack is used to support the base of the machine. These can be adjusted to any height within their scope and the machine can thus be accurately leveled in a few minutes' time. Their construction is simple, as will be seen by reference to the enlarged view at the right-hand side of the illustration.

A piece of three-inch extra heavy pipe *A* is threaded for a short distance on one end and is fitted with a flange *B*

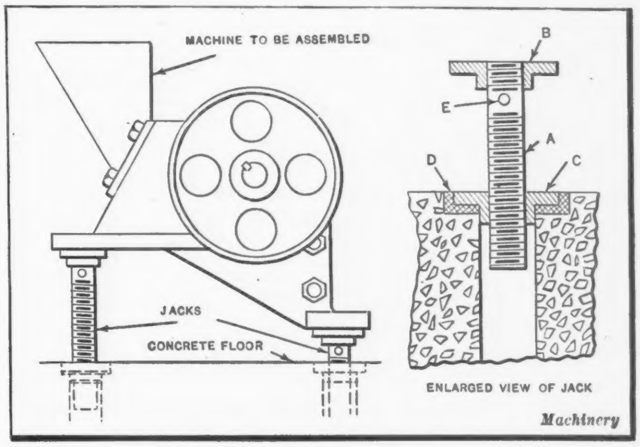


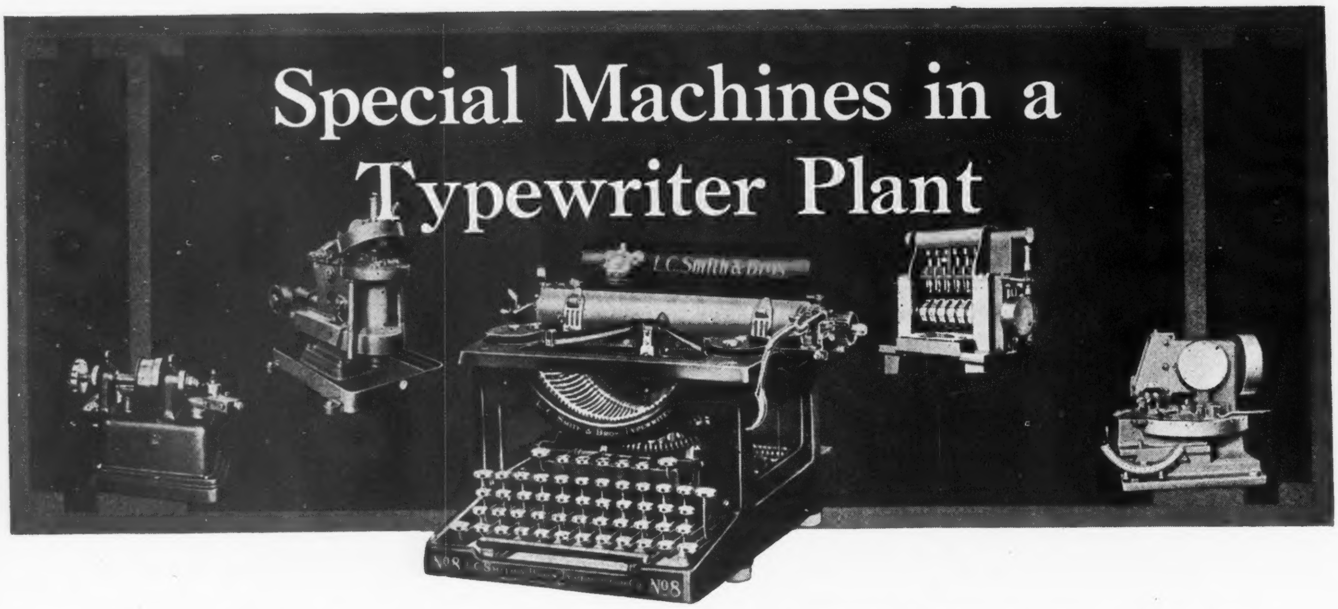
Diagram illustrating Method of employing Floor Jacks for assembling Machinery

whose face is at right angles to the central axis of the pipe. The other end of the pipe is threaded straight up to within three inches of the screwed-on flange. A good strong floor flange *C* is then threaded straight so that it is a good turning fit on the threaded pipe. Holes are cut through the concrete floor at the places best suited for supporting or assembling the work, consideration being taken for good light, overhead crane facilities, etc. These holes are of the same diameter as the hub of the flange *C*, and can be lined with a stove-pipe tube if so desired.

A counterbore or enlarged top opening allows the flange proper to lie flush with the floor surface. When these flanges are placed in position, a perfect seating can be made for the flange by mixing a little cement topping and using it below the flange in the enlarged hole as shown at *D*. It is important that these flanges in the floor be cemented in dead level, as the squareness of the upright and adjustable screws depends on this. Holes *E* are drilled for an elevating bar as shown.

With a set of erecting jacks of this kind, the workmen have an unobstructed view and entrance to the lower parts of the machine, which is often a necessary condition in assembling work. Unequal base heights are easily taken care of, as shown in the view at the left-hand side of the illustration. When not in use, the floor flange *C* can be closed with a pipe plug. The length of the pipe screw depends on the size and height of the machine castings to be assembled.

Special Machines in a Typewriter Plant



Unusual Mechanisms Incorporated in the Design of Special High-production Machines

By CARL GABRIELSON, L. C. Smith & Bros. Typewriter Co., Syracuse, N. Y.

THREE special machines used in the plant of the L. C. Smith & Bros. Typewriter Co., Syracuse, N. Y., were described in an article in September MACHINERY. The present article will describe three more machines used in the same plant. These machines, like those previously described, operate automatically except for loading and unloading the work. The machine illustrated in Fig. 1 is employed to cut two rows of slots *A* and *B* in the type-bar segment illustrated in Fig. 2. There are forty-two slots in each of these rows. The slots are of equal width, but their spacing increases toward both ends, because the outer bars require more room than those near the center, on account of the angle of the type with the center of the bar.

Two opposite slots are cut at one time by means of two cutters *A*, Fig. 1, mounted in a head *B* which has a vertical traverse, the work-table being indexed automatically from right to left around a curve between each reciprocation of the cutter-head. The machine stops automatically as the cutter-slide ascends after having finished the last two slots.

Slide Reciprocating Mechanism and Indexing Arrangement

The driving pulley *C*, Fig. 3, is mounted on a horizontal shaft from which the drive is delivered through spur gears *D* to a second horizontal shaft, at the front end of which helical gears *E* are mounted. These gears drive the cutters through helical gears *F* at the left-hand end of the cutter-shafts. Power for operating the various automatic mechanisms is taken from the pulley shaft through spur gears *G*, which drive the shaft that carries worm *H*. Worm *H* and the worm-wheel with which it meshes, drive a shaft in the head of the machine on which are mounted cam *I* that operates the cutter-slide and cam *J* that operates the indexing mechanism.

The teeth of rack *K* in the cutter-slide mesh with those of the gear segment *L* which has an arm that carries the roller *M* at its end. This roller is held constantly against the periphery of cam *I* through the action of the coil spring *N*, which normally tends to raise the cutter-slide, and thus presses the roller firmly against the cam. The cam revolves in a counter-clockwise direction, and when the raised part of its periphery reaches the roller, segment *L* is swiveled to lower the cutter-slide. Conversely, when the low section of the cam again reaches the roller, segment *L* is swiveled back due to the action of spring *N*, thus raising the cutter-slide. The shaft on which the lower one of gears *D* and the helical gears *E* are mounted is equipped with two universal joints to permit a change in the relative positions of gears *D* and *E*.

At each revolution of the shaft on which the cams are mounted, the lobe of cam *J* depresses rod *O*, which, in turn, actuates rod *P* through levers *Q* and *R*. Referring now to Fig. 4, which illustrates the indexing mechanism, it will be seen that the opposite end of rod *P* to that which comes in contact with lever *R* is attached to the bellcrank lever *S*. The second arm of this bellcrank swings link *T* in and out so that its tooth successively engages the tooth spaces in plate *U*, attached to the shaft that actuates the work-table. The periphery of this plate has forty-two tooth spaces which are so located as to index the work to suit the spacing of the slots to be milled.

When rod *P* is released and bellcrank *S* swivels back, the tooth on link *I* is withdrawn from the space in plate *U*, and at the same time a small nib at the top of the stud that secures bellcrank *S* and link *T* together, operates in a slot in part *V* and causes this part to turn in its bearing. Part *V* has a curved surface that registers with a corresponding surface on link *W*. The latter also has a finger that enters the same tooth space in plate *U* as the tooth on link *T*, preventing link *T* from indexing plate *U* more

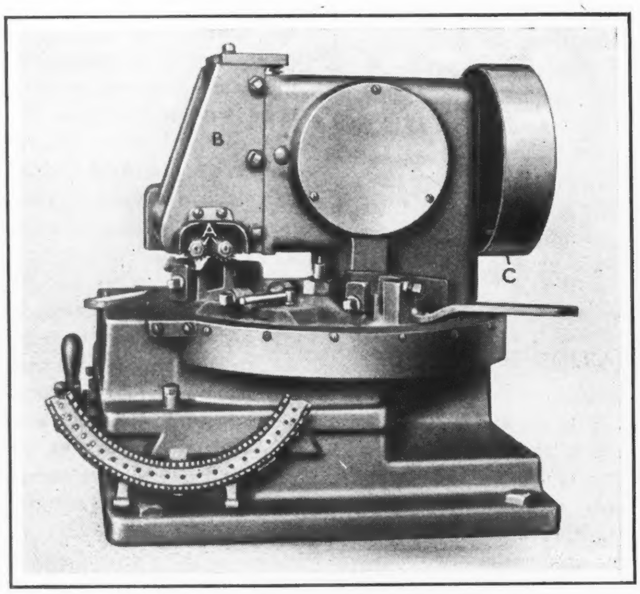


Fig. 1. Machine employed for milling the Eighty-four Slots in the Type-bar Segment of the Smith Typewriter

or less than the proper amount. Because of the curved contact surface of links V and W, the latter is also turned in its bearing as link V is swiveled, thus withdrawing its finger from the tooth space in plate U and releasing this plate for indexing.

Link T is pulled back an amount slightly greater than the largest tooth space in plate U, when bellcrank S is

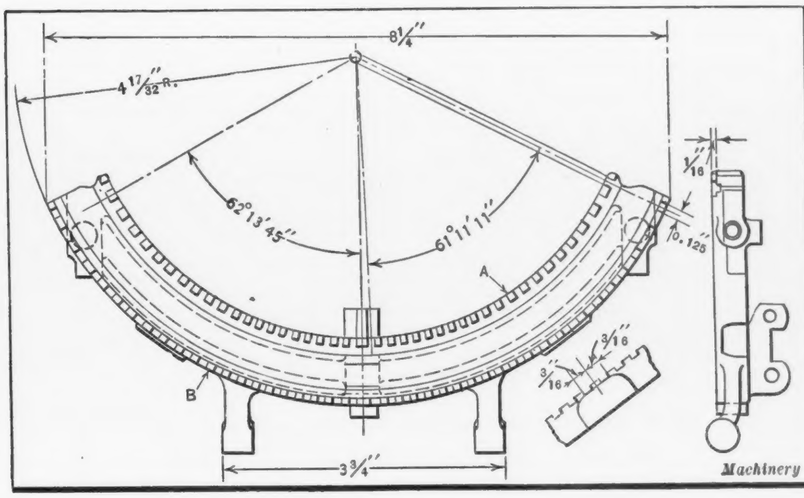


Fig. 2. Type-bar Segment used on the Smith Typewriter

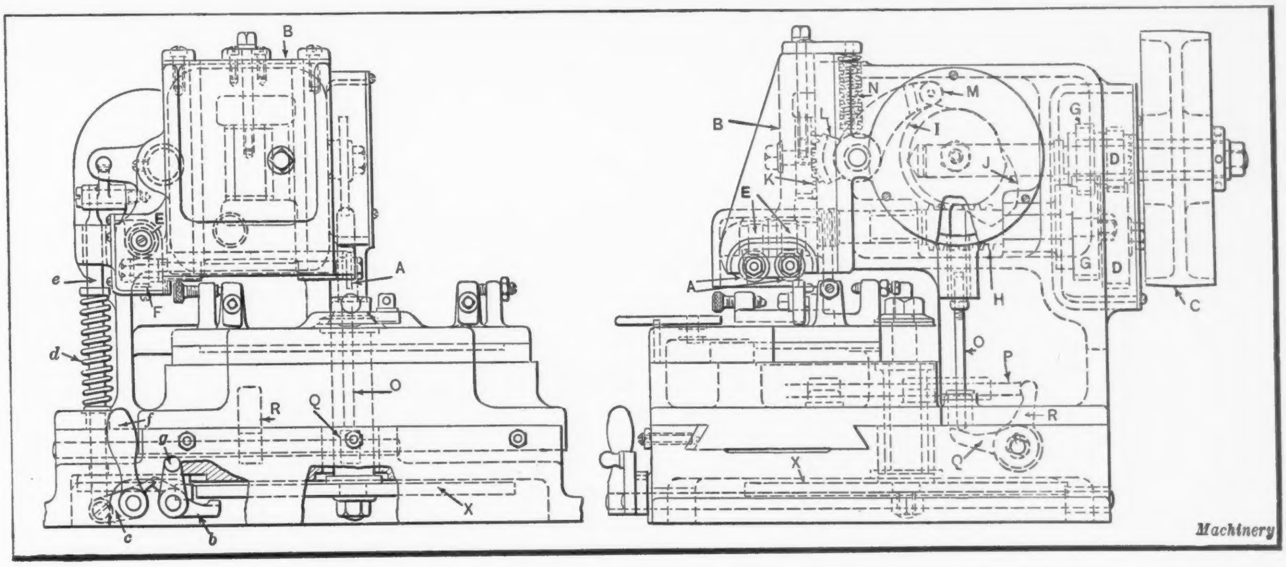


Fig. 3. Assembly Views of the Type-bar Segment Slot Milling Machine illustrated in Fig. 1

swiveled, and when link T is again pushed forward, its finger enters the next space in plate U and indexes the plate until the finger of link W is swung into the same tooth space by a lug on link T coming in contact with pin a on link W. The outer end of bar Y prevents the finger on link T from entering any tooth space other than that immediately following the one it previously occupied. Bar Y is rocked to and fro by means of a roller contacting with the periphery of a large plate cam.

Near the lower end of the table spindle to which plate U is attached there is a cam X, Fig. 3, carrying a lug on the under side that strikes one end of lever b when the work has been finished. During the operation of the machine, the opposite end of lever b has locked link c in the position illustrated but when link b is swiveled, it releases link c and permits spring d to raise rod e. This action disengages the driving clutch on the pulley shaft and stops the machine. After a new piece of work has been put in place and the table has been returned to the starting position, the feed is again engaged by swinging handle f to the right and handle g to the left, once more engaging links c and b.

A machine for milling groove A in the sub-lever segment illustrated in Fig. 5 is shown in Fig. 6. This groove is 0.130 inch wide, and ¼ inch deep. The salient point in the construction of this machine is the means employed for stopping the table feed when the work is finished. The groove milled in this

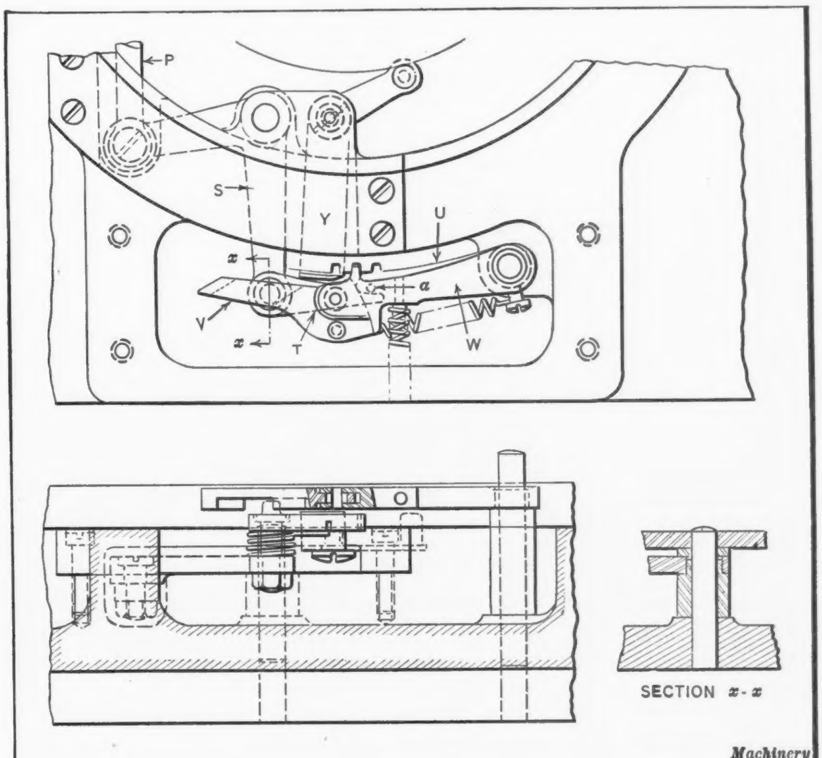


Fig. 4. Arrangement of the Indexing Mechanism incorporated in the Slot Milling Machine shown in Fig. 1

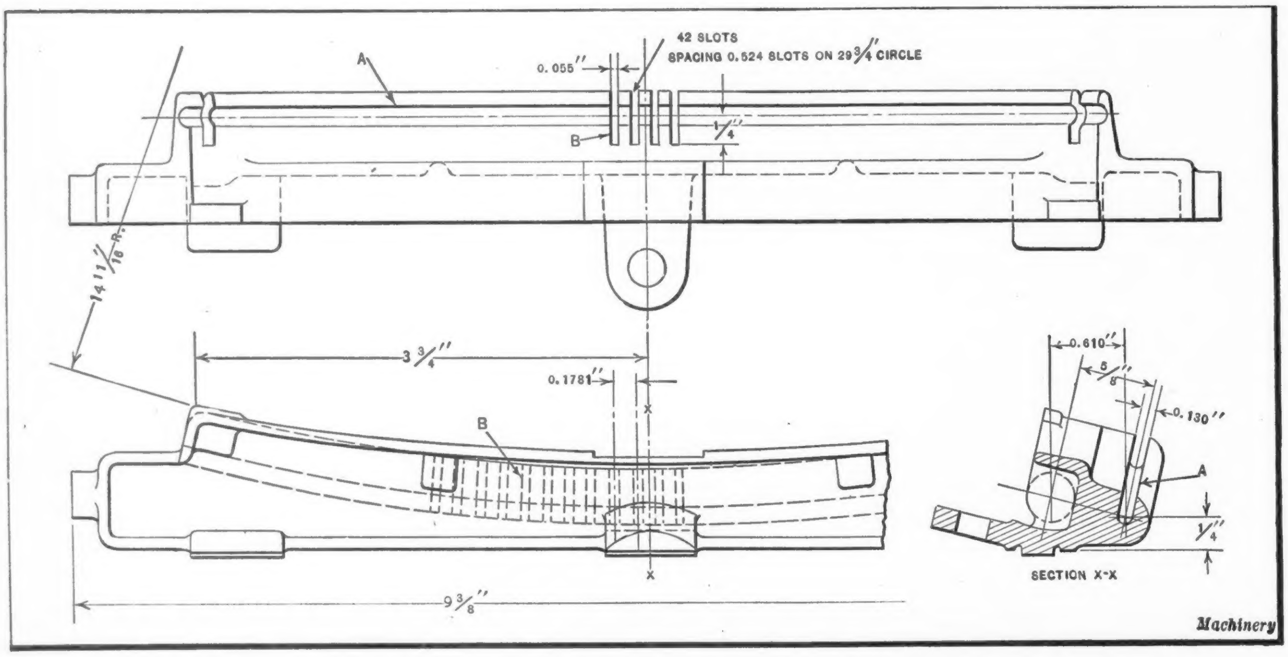


Fig. 5. Sub-lever Segment in which the Groove and Slots are milled by the Use of the Machines shown in Figs. 6 and 7

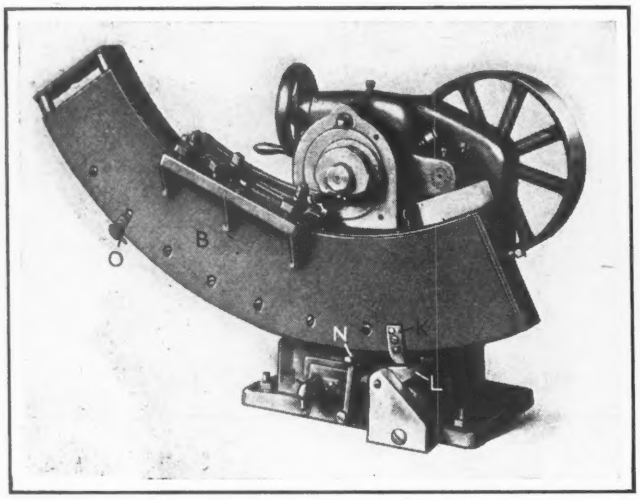


Fig. 6. Machine in which the Wire Groove is milled in the Sub-lever Segment

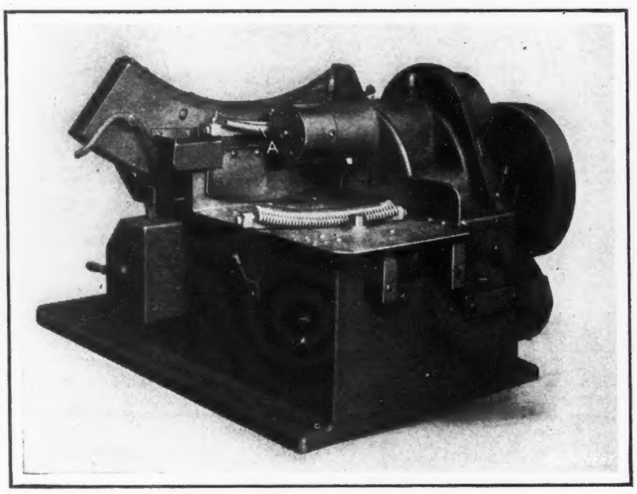


Fig. 7. Machine used for milling the Forty-two Slots in the Sub-lever Segment

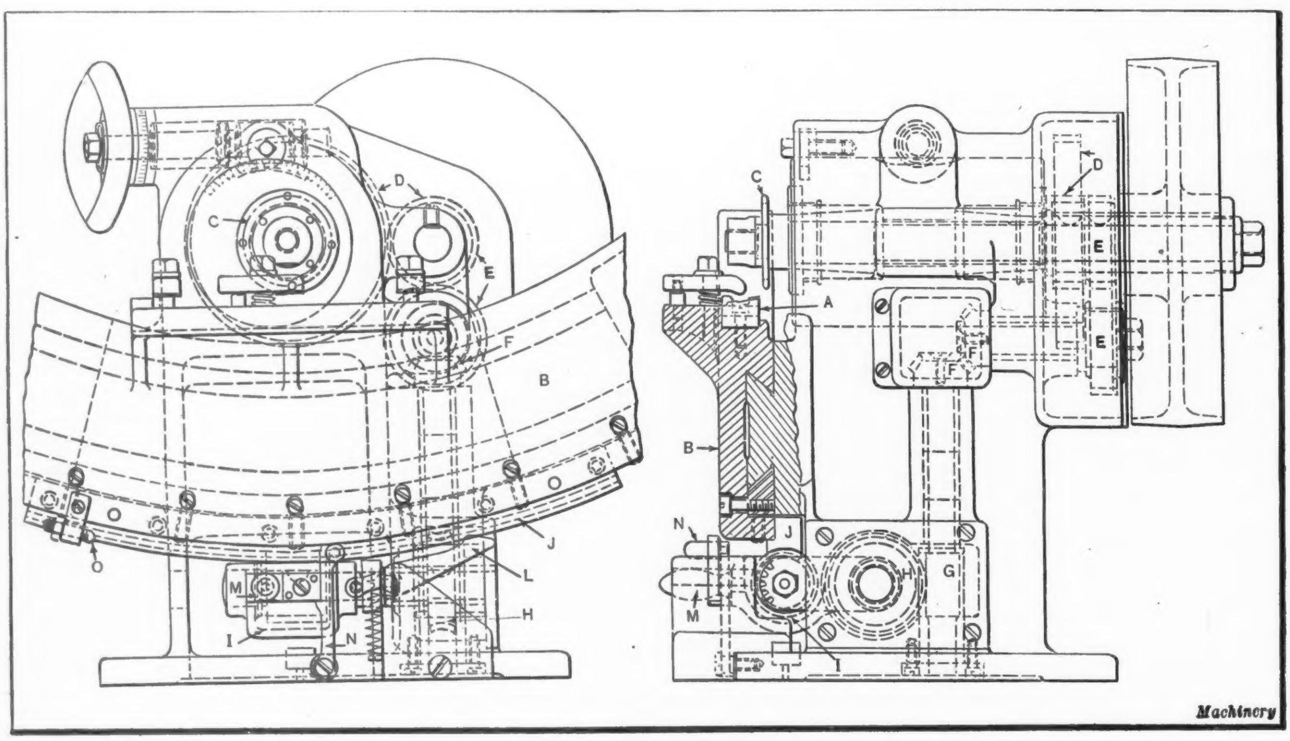


Fig. 8. Assembly Views of the Sub-lever Segment Wire Groove Milling Machine

operation receives a wire for holding the sub-levers during the assembling of the typewriter. The details of the design may be studied from the view Fig. 8. The work is clamped on block *A*, which is inserted in a slot running along the shelf at the top of carriage *B*. Cutter *C* is mounted on a shaft running parallel to the driving shaft, and is driven from it through reduction gears *D*. As carriage *B* is fed from left to right past the cutter, the groove is milled in the work. The driving pulley runs at about 300 revolutions per minute, and the cutter at 122 revolutions per minute.

Power is transmitted from the driving shaft through spur gears *E* and miter gears *F* to a vertical shaft with which worm *G* is integral. From this point the drive is delivered through worm-wheel *H* and a train of spur gears to worm *I* which meshes with the circular bronze rack *J* is attached to the lower side of carriage *B*. It is obvious then that carriage *B* is fed from left to right as worm *I* is revolved. When the operation has been completed, worm *I* is disengaged from the circular rack as will be described later, and stops the feed of the carriage.

At the beginning of an operation, carriage *B* is pulled to the extreme left by means of a handle on that end until finger *K*, Fig. 6, contacts with latch *L*. These members prevent the carriage from being pulled so far to the left that worm *I* could not be engaged with rack *J*, Fig. 8. After the work and carriage are in place, handle *M*, Fig. 6, is lifted to raise the worm into engagement with the rack, and handle *N* is pulled to the left until a lug on it registers with a seat on the worm-box to support the latter. The feed of the table will then be continuous until the stop-screw *O* contacts with lever *N* and throws it to the right sufficiently to permit the worm-box to drop, disengaging the worm from the rack and thus stopping the feed of the carriage. The worm-box falls on a fiber pad so as to lessen the shock. A micrometer device at the top of the machine provides for accurately setting cutter *C*, Fig. 8. It will be observed that the carriage slides on a dovetailed bearing to which it is gibbed.

Slotting the Sub-lever Segment

A second operation on the sub-lever segment that involves the use of a unique machine consists of milling the forty-two slots *B*, Fig. 5, which receive the sub-levers. These slots are 0.055 inch wide, about 7/16 inch deep, and spaced 0.1781 inch apart. They are milled on an extension of the casting which is curved to a radius of 14 11/16 inches, and so it is necessary in this case also to hold the work on a carriage

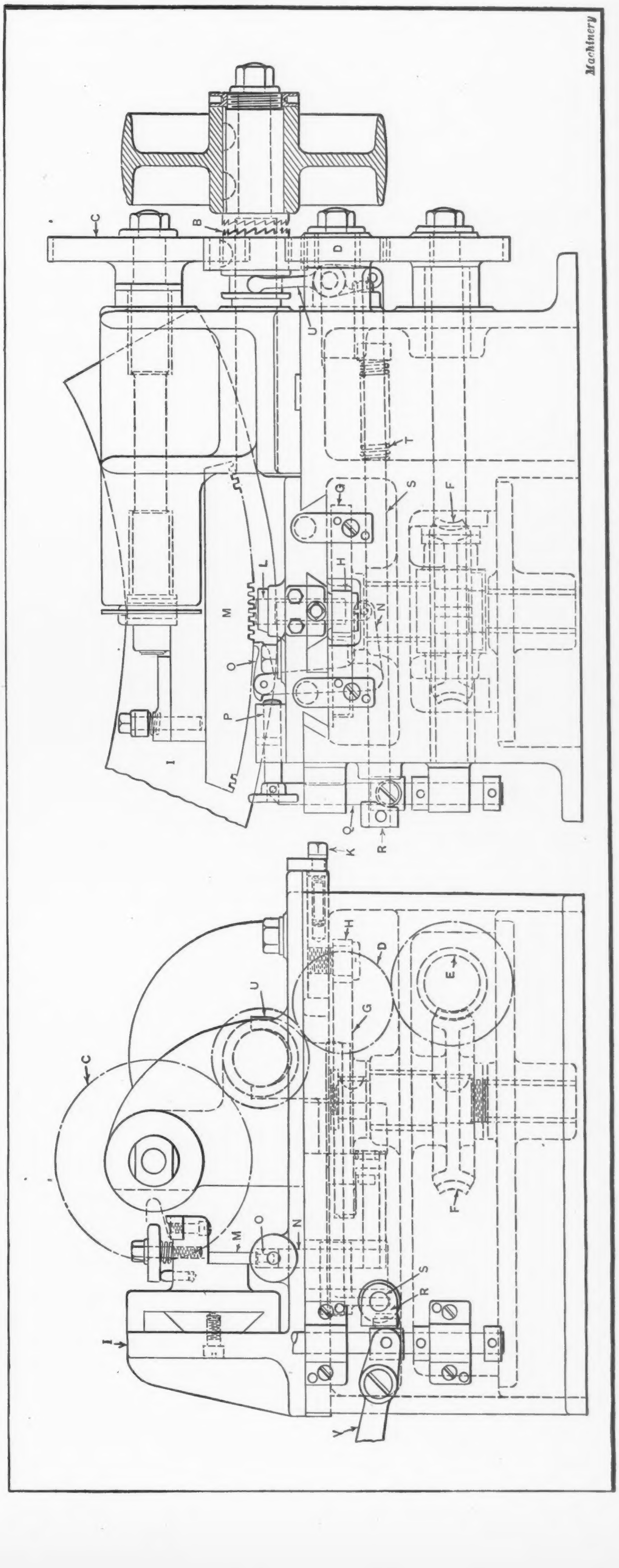


Fig. 9. Assembly Views of the Construction of the Sub-lever Segment Slotting Machine

that follows an arc as it is traversed past the cutter. The location of the work on the machine is indicated at *A*, Fig. 7.

The cutter is held in a stationary position, the work being withdrawn after each slotting, indexed, and then advanced to the cutter again. This machine is also stopped automatically at the completion of the entire operation. The construction of the machine as it was originally designed is illustrated in Fig. 9. Although the machine has since been modified, as will be seen from Fig. 7, the original design is of sufficient interest to warrant a description.

The drive from the pulley to the machine is by means of clutch *B*, Fig. 9, which is operated by a mechanism that will be described later. A gear on the clutch-shaft meshes with gear *C* to drive the cutter-shaft, and with gear *D* to transmit power to the feeding mechanism. Through a mating gear, gear *D* drives the shaft on which worm *E* is mounted, the worm in turn, driving through worm-wheel *F*, a vertical shaft at the top of which is attached the plate cam *G*. Roller *H*, which is secured to the under side of work-slide *I*, contacts with this cam and so, as the cam revolves, the slide is advanced toward and withdrawn from the cutter once at each revolution. The roller is held against the cam by a spring, the pressure of which is regulated by screw *K*.

The work is held stationary for each slotting by a tooth on the upper end of the spring-actuated plunger *L* engaging a tooth space on the rack segment *M* which is secured to the work-table. The rack has forty-two teeth spaced to suit the slots in the work. On the under side of cam *G* there is a lug that strikes a member and causes bellcrank *N* to rock once forward and backward at each revolution of the cam. On the forward movement of the bellcrank, finger *O* is raised into engagement with a tooth space of rack *M* through the action of a spring (not shown) and at the same time the bellcrank withdraws plunger *L* from engagement with the rack. Then as the bellcrank completes its forward movement, the action of finger *O* on rack *M* indexes the work-carriage the desired amount. As the bellcrank rocks back, plunger *L* enters the tooth space of rack *M* succeeding that previously occupied, and at the same time finger *O* is pulled out of engagement with the rack by the end coming in contact with plunger *P*.

When the operation is completed, a lug on the right-hand end of the carriage, as viewed from the front, strikes the upper beveled end of rod *Q*, depressing it and actuating cam *R*, so that rod *S* can be pulled to the right through the action of spring *T*. This causes yoke *U* to swivel and pull clutch member *B* out of engagement, thus stopping the machine. When the carriage has been reloaded and returned to the original position, the machine is started again by operating lever *V*, which raises rod *Q* and once more engages the driving clutch. The main difference between the present design and that shown in this illustration is in the tripping mechanism. A bellcrank has been substituted for the lug on the right-hand end of the carriage, and a lever for rod *Q*. The inner end of the bellcrank prevents pawl *O* and plunger *L* from engaging the rack at the completion of the operation, so that the carriage can be pulled back to the starting point.

* * *

The recent arrival in Philadelphia and Pacific ports of 5000 tons of pig iron from India at prices that compete with American pig iron has aroused considerable interest relative to the ultimate export possibilities of India. Japan has imported in the past considerable amounts of pig iron from India, but Chinese iron and steel works will probably be able to supply the Japanese demand in the future. The Indian output is therefore likely to be sold in Europe and America. India has large supplies of easily accessible high-grade iron ore, as well as plentiful supplies of manganese and coal, and it is probable that the iron and steel industry in India will develop to considerable proportions.

GRINDING MALLEABLE CASTINGS

Opinions differ as to whether malleable iron castings such as are used in railway equipment, agricultural machinery, and automobiles should be ground in the unannealed or the annealed state. Some foundrymen believe that grinding in the annealed state is preferable, while others, for apparently just as good reasons, advocate grinding in the hard state. The advantages and disadvantages of grinding malleable castings in the annealed and unannealed states were set forth in an article by E. C. Hughes in *Grits and Grinds*. In this article it was pointed out that some manufacturers make a practice of grinding malleable iron in the hard or unannealed state not because it is cheaper but because the resulting product is preferred by the purchaser.

When grinding is done in the hard state, with annealing as the final operation, all grinding marks are removed and a better looking casting is obtained. If this method is not used, the only way to eliminate the marks is to reanneal or sand-blast the work, which, of course, increases the cost. In the opinion of some, malleable iron in the hard state is easier to remove with a grinding wheel than in the soft state, for it is claimed that the wheel cuts cleaner and the hard metal does not tend to smear or load the wheel as much as the soft. The reason given in some cases for grinding before annealing is that, if the casting is burned in grinding, the harm done is much less than if the iron is annealed. A casting burned in the soft state will have hard spots that are very difficult to machine in later operations. Therefore, when castings are to be machined after the grinding operation, it is advisable to do the grinding while the iron is in the hard state.

If grinding is done after annealing, trouble will be experienced with hard spots or "crystallization." This condition is not usually detected until the machining operations are started. It is probable that grinding in the hard state is more rapid on heavy gates, as no attention need be paid to the heat generated in grinding, since annealing either corrects this or shows up any "crystallization" of the metal which has taken place.

There is no question that it is cheaper to grind the castings after they are annealed. With the hard castings there is a much higher labor cost per casting produced, and the grinding wheel cost per pound of material removed is higher, not only because the wheel used costs more, but also because there is more resistance to grinding and greater physical effort is required on the part of the operator.

These conclusions are borne out by actual tests. One test which shows the lower grinding cost on annealed castings was conducted in the foundry of a large producer of malleable castings. In this test alundum wheels were used on the annealed castings, and crystolon wheels on the unannealed castings. The former had an average wheel life of 34½ hours and a wheel cost of $14.41, while the latter lasted, on an average, 20½ hours and showed a wheel cost of $17.23.

The fact that, under the particular conditions met with in this foundry, the cost per ton of castings ground in the annealed state is about one-half that when they are ground in the hard state, is a strong argument in favor of grinding in the soft state. In spite of arguments pro and con on this question, the wheel user must decide the question of whether he will grind castings in the soft or hard state from a study of the particular conditions surrounding his work. Whatever his decision, it is recognized that the foundry lay-out for one method should be somewhat different from that for the other. Much can be said for both methods, and the choice will often be made upon consideration of the type of product being turned out.

* * *

The total number of registered cars and trucks on July 1 this year exceeded 13,000,000—a gain of 2,440,000, as compared with a year ago.

Selection and Use of Diamonds for Dressing Grinding Wheels

By WARD M. ROBINSON

THE increase in the variety and amount of work handled on grinding machines in the automotive industry in the last few years has brought about the everyday use of diamonds for truing or dressing grinding wheels. Notwithstanding this fact, however, there is very little data or information to be found in print regarding the selection, mounting, and use of diamonds for wheel-truing purposes. In this article, the writer has endeavored to make clear the general practice in handling this work, and to present some original information on the use of truing diamonds that may be of value to experienced stone-setters or "shop jewelers."

Record of Stones Purchased

The moment a shipment of diamonds is received a card or some other form of well established record should be overlooked, which may result in the needless expenditure of hundreds of dollars, whereas with a record of some kind, close analysis can be made of past performances, and the blame, if any, properly placed, so that steps may be taken to avoid further trouble of a similar kind.

Points on Selection of Stones

Some of the factors that must be taken into consideration by the buyer and set-up man are size, quality, shape, flaws, and purpose for which the stone is to be used. The size, shape, and quality of the stone, of course, generally determine the use to which it is put, but occasionally it becomes necessary to set up a machine for a special job, or some emergency arises wherein any diamond that is unset must be used, regardless of the three factors mentioned. In taking into consideration the size of the diamond, it is always best (granting that the quality is good) to use the larger or heavier stones, for truing the coarser grinding wheels. It is also a good policy to buy the larger and harder stones, as they are more likely to be rugged and have the ideal eight points. In case of breakage, the chips from the larger stones are usually large enough for further use, which, of course, means greater economy in the long run.

DIAMOND RECORD No.

Purchased From	Date	Weight	Price	Grade	Total Dressings Average Cost

Delivered to	Delivered by	Date

DATE ISSUED	WEIGHT	Employee's Name or Number	DEPT.	DATE Returned	Transferred or sent out to be re-set	Weight after Re-setting	Amt. lost or Scrap	DRESSINGS	COST PER DRESSING

Fig. 1. Form on which Record of Truing Diamonds is kept

made for each stone. As may be seen in Fig. 1 (which is a very satisfactory type of record sheet worked out for a full letter-size loose-leaf book), spaces are provided for recording the class and weight of the diamond, the name of the company from whom it was obtained, and the cost per carat. Space is also provided for recording the results actually obtained with the stone. This record is invaluable as an index to quality, and should always be consulted before purchasing a new lot of diamonds; for example, an inspection of the record might show that a certain grade of stone was costing more per wheel dressing than the average stone in its particular class. It might be found that the stone in question gave, say only 80 per cent of the average run of dressing cuts. If it were determined on further investigation, that the poor record made by these stones was not due to some of the lot being burnt, chipped, or lost, it would be evident that they were not satisfactory and should be replaced by a different grade.

Stones that have been chipped are sometimes returned to the tool-room from the production grinders. In such cases the question arises as to where the blame is to be placed—on the grinder operator, the diamond setter, or the diamond itself. If no records of the stones are kept, it is very easy for a great number of breaks, mishaps, or mistakes to be

Frequently it will be found that the larger stones have a tendency to wear pea-shaped so that they are of little use until reset. Of course further wear would tend to bring up points and edges at the borders of the worn surfaces, but this is not only expensive, on account of the useless wear on the diamond, but also is likely to result in cracking or overheating of the stone. The usual method of rotating the setting in the holder both radially and axially cannot be avoided, although this is what gives the stone its objectionable spherical shape, as indicated at *A*, Fig. 2. It will be noted that such a diamond has hardly a point or clean edge that could be used for truing a grinding wheel.

Splitting Worn Diamonds

If an ordinary diamond of two or three carats is held up to a bright light, the eye being protected with the hand in

much the same manner as when candling eggs, it may be noticed that the stone has dark streaks or lines. These streaks or lines appear to a greater or less degree in all commercial stones and are called cleavage lines or flaws. If the stone is held against a hard edge, flush and parallel with the cleavage line, and a sharp blow struck on the opposite side and across the border line, a clean fracture will result, just as though the stone was sheared. This practice is used to rough-shape a gem in the jewelry trade so that no flaws will remain in the finished product to interfere with the light refraction from the various facets. However, the splitting operation should be performed only by an expert. The point to be made here is that when a stone has become worn so nearly spherical that further use is not economical, it should be sent to a responsible shop to be split into three or four usable chips having a number of working points.

Some of the diamond dust and chips that are too small to be used will also be returned with the split diamonds. The chips and dust that cannot be used for wheel-truing purposes are readily salable. The dust is used in laps for various purposes, and the chips for different types of glass-cutters, fine diamond-pointed saws, etc. A large amount of the diamond dust and chips thus salvaged eventually finds its way back to the gem cutting industry.

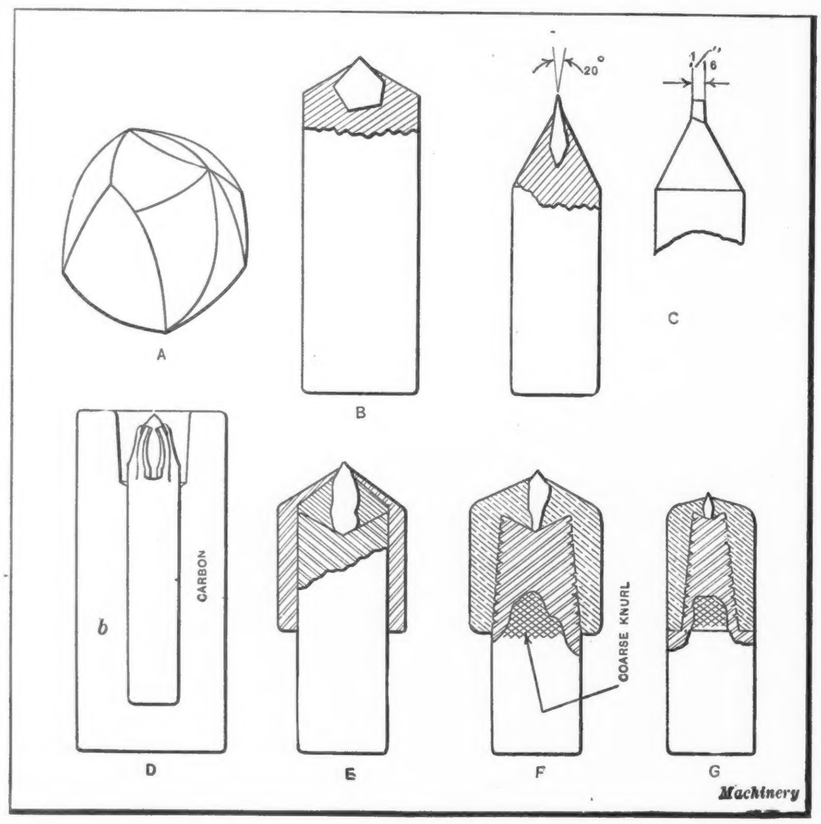


Fig. 2. Types of Holders used for Diamonds

The mounting of a large stone should be much heavier, comparatively, than the mounting of a smaller stone, or perhaps it should be said that the mounting of the larger stone ought to be more dense. This is necessary on account of the relatively greater distance from the point to the anchorage or gripping metal. Failure to follow this rule often results in a loosened or lost stone. Furthermore, the backing or metal around the base of the large stone should be more secure for the reason that the operator has a tendency to take deeper or heavier cuts with the larger stones.

Quality of Diamonds

The price of a diamond bought from a reliable house is generally a good index to its quality, although this does not mean that a close watch on market prices should not be kept. The three general quality classes are the bort, the ballas, and the Jagers-Fontain. The bort is further classified according to color. In some cases, the type of work to be done may determine the class of stone to be used. For instance, a very fine dressing operation on a formed wheel usually demands a Jagers-Fontain stone on account of its extreme hardness. On the other hand, this stone is noted for its chipping propensities when used on a rough wheel or for a heavy cut.

The ballas is a crystal white stone, which is not so hard as the Jagers-Fontain, but has the advantage of being tougher, and is therefore considered by some to be the cheaper stone for all-around use. The bort is somewhat softer than either of the other two classes of stones and loses its point very much quicker, but it is considerably less expensive and it is believed by some that the lower price more than makes up for the difference in the wearing quality. On several occasions the writer has come across stones (the classification of which he does not know) which have for their distinguishing features surfaces that feel greasy or slippery to the touch, a decidedly pink hue and an absence of extremely sharp points or edges. These stones, although particularly hard to handle and set up on account of their slippery surfaces, almost never break when used with reasonable care, and their wearing quality is surprisingly greater than that of the average run of stones. In size, these stones never run above 1 or 1¼ carats.

Hardness of Truing Diamonds

Hardness combined with a lack of brittleness is, of course, the quality most desired in diamonds that are to be used for truing up grinding wheels. The diamond is the hardest known substance, the hardness being rated as 10 in the mineralogist scale of hardness. There is however, a considerable variation in hardness between the different types of stones, and there is even a noticeable difference in hardness between some of the diamonds in one run-of-mine shipment. This will be indicated in the record by the column that shows the number of times each stone is used before resetting becomes necessary. The shape is one of the most important factors to be considered in mounting the stone. A stone with six to ten sides is best for general use, but the run-of-mine stones will be all shapes and sizes and the ideal stone may not always be available.

Position of Stone in Holder

An important factor governing the setting is the shape and position of the points on a stone. Needless to say, the point should be placed as nearly as possible in a central position, so that a line representing its axis will fall along the axis of the mounting. One reason for observing this precaution is the tendency of the operator to rotate the mounting axially in its holder in order to present new points or edges to the wheel. If the point of the stone is off center to any considerable extent, the rotation of the holder may throw it far enough off to cause it to break when it comes in contact with the wheel. Another reason for having the stone centered in the holder is that a better anchorage is usually obtained in this way. When the point is on the center, it is generally safe to assume that the stone is well covered or enclosed by its setting. The ideal condition in this respect is illustrated by the view at *B*, Fig. 2.

The major portion of the stone should, of course, be embedded in the holding metal, but if the stone is too smooth on the buried portion, it may become loosened. This is another argument in favor of splitting stones that have become worn to a spherical shape. Certain classes of work will demand a stone of a certain shape. For instance, one type of fixture used for forming spline-grinding wheels requires a long, thin, wedge-shaped splinter similar to the one shown in the holder illustrated at *C*. Because of the fine work for which this shape of stone is intended, it rarely runs over 0.2 carat in size, so that in many instances the required shape may be found among the salvaged chips.

The usual method of mounting is to set the diamond in an over-size, extra long holder, taking care to keep it as nearly central as possible. After the brazing operation has been performed and the point brought to light by grinding away the surplus metal, the holder is set up in an independent jaw chuck and the point of the diamond indicated dead true. The shank of the holder is then turned down to size and cut off to the required length. Formed diamonds and multiple settings designed to produce a given form on the wheel have been used in the past, notably for the purpose of dressing gear-tooth grinding wheels, etc. This practice, however, is expensive and is not general.

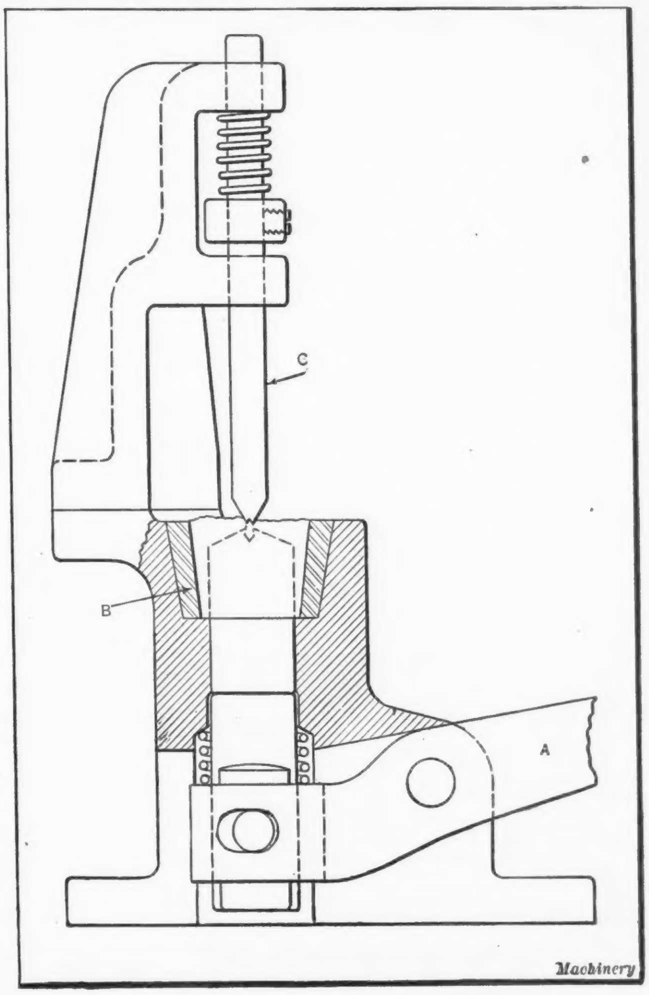


Fig. 3. Fixture used in setting Stones in Holders

Rapid Cooling of Diamonds should be Avoided

One of the greatest abuses to which shop diamonds are sometimes subjected is that of cooling the stone too quickly. There are many operators who, through a lack of knowledge or absent-mindedness, put a stone to work and when it has become hot, suddenly remember that there is a good supply of cold water at hand and turn a large stream of water directly on the stone. Naturally, the result is a shattered stone, and the salesman is often blamed for furnishing a poor quality stone when the trouble was actually caused by improper treatment by the workman. The chips from a stone that has been split up by careless treatment of this kind are seldom worth the labor of resetting, as the buried portions in the old setting that have not come into contact with the air have usually undergone a physical change which renders them relatively soft, dark in color, and incapable of holding an edge that is suitable for wheel-dressing.

Too heavy a cut across a wide-faced wheel, under the best of conditions, will also cause the stone to split up and undergo the physical change referred to. Actual burning of a stone is the result of using too hot a flame in the brazing process. A temperature of over 1800 degrees F. is likely to spoil the stone, and at a temperature of 2200 degrees F., many stones are transformed into carbon dioxide gas. A good clean cut and a true stone surface can rarely be obtained when a stone is loose in its setting or is set in a shaky fixture. The same trouble results when the stone is held in the hand, as is frequently done in forming a corner radius or running down the side of a wheel. Flaws—the distinct cleavage lines previously referred to—should be kept perpendicular in the setting and as nearly parallel with the axis of the holder as possible.

Methods of Setting Stones in Holders

In considering the methods of setting diamonds in their holders, only those settings will be described that the writer has actually employed. It is hardly necessary to describe the prong or Tiffany setting, such as shown at *D*, Fig. 2, as this is the most widely used type. Even where other methods are in vogue, this setting is frequently resorted to for special cases. It might be of interest, however, to note the method of overcoming the difficulty of brazing when very small stones are to be set in small shanks. An acetylene torch may be used for this work, the flame being very small and kept away from the top of the mounting as much as possible because of the rapidity with which small prongs absorb the heat.

Warped prongs with the resultant change of position of the peened-in stone are faults often found in the type of setting referred to. To eliminate this trouble, a stick of carbon *b*, 1¼ inches in diameter (such as a gas welder uses to protect finished holes), is drilled out slightly larger than the size of the shank which is placed in it (with the stone in position) as indicated at *D*. A good sized torch flame is then directed around the outside of the top of the carbon, which, when it becomes incandescent, readily melts the small gage brass wire or brazing material inside the cup. This method is somewhat slower than that usually employed, but it has the advantage of giving practically perfect settings. There is no reason why the carbon crucible *b* could not be used in welding or brazing the work by means of electricity, provided suitable electric currents are available.

The special holder shown at *E*, Fig. 2, has been found to give fairly good results, the only fault being that a great deal of work is necessary to fit up the holder itself in order to insure a good seat for the stone at the outer end. In using this setting, care must be taken to see that the cast material around the stone is kept as free from dirt as possible. In setting a stone in this type of holder, a mixture of fine brass filings and a flux is first packed down around the stone, after which the plug is tapped down lightly to hold the stone in place. The holder is then inverted in a simple fixture with the stone downward, resting on a soft metal mat.

While the mixture is being heated by the torch, the plug is forced slowly downward so that the plastic metal is squeezed out at the end and all around the stone. If all conditions are favorable, a perfect bed for the stone will be formed by this method. The excess metal is then ground

away, leaving the point of the stone exposed. The advantage of this setting lies in the fact that there is a solid ring of steel around the stone and unless a great deal of the metal is carelessly ground away, it is practically impossible for the stone to become loose.

A type of holder that enables the stone to be set in much less time is shown by the views at *F* and *G*. The holder at *F* is used for large stones, while the one at *G* is employed for holding comparatively small stones. The shanks of these holders need not be discarded when a stone has become worn, but may be used over and over again. The fixture shown in Fig. 3 is used for setting the stones in place. The stone is held by plunger *C*, and the mixture is melted in a graphite crucible and poured in around the shank. The complete casting is then stripped from the mold by means of lever *A* and finished up in a lathe, thus producing finished holders such as shown at *F* and *G*, Fig. 2.

In setting stones by this method, it is necessary that the metal be kept clean and that it be melted and poured at the correct temperature. Care should also be taken to have the fixture properly preheated. The molten metal must be poured evenly and without any interruption, in order to prevent seams or laps. If these occur, however, they can in most instances be repaired quickly and efficiently by brazing with a small torch flame. When small mountings are to be used, the bushing or liner *B*, Fig. 3, is used to save metal.

Method of Melting Diamond-holding Metal

The gas torch may be used successfully for heating, melting, and welding or brazing the metal in which the diamond is set. The tip used on the torch should, of course, be changed to suit the requirements of the work. An electric melting pot has also been used, which, although requiring a little more time to put in operation, has proved a time-saver in the end, as it requires practically no attention from the workman. The inside diameter of the graphite crucible used in the melting pot is 1¾ inches. A crucible 1 inch inside diameter and perhaps 5 inches deep would be much better than the type referred to. Two heating elements could be used with a crucible of the latter type, or a special coil might be built up for the purpose. The cost of this outfit need not be prohibitive, and the current used would not greatly exceed in cost that of the acetylene and oxygen required for the gas-operated torch.

Material Used in Brazing

The ideal metal for brazing or casting should, of course, melt at a very low temperature, and be tough but not too brittle when cold. The great trouble with copper or high copper content brasses (although these are usually easy to work) is that they are too plastic, and the diamond, when under stress, soon enlarges its seat and becomes broken or lost. A type of welding rod known as "silver bronze" was found to hold the stone more securely than any other material tried out, but the melting point of the metal was so high that there was danger of injuring the stone when it was employed.

Cast iron and steel cannot usually be used successfully for this work due to the high temperatures required to melt them. Monel metal, however, is said to have been used successfully at several plants. A number of experiments have been made with aluminum alloys in combination with tin, copper, and antimony and zinc. These alloys, however, proved to be too soft or melted at too high a temperature. Several types of ordinary brass welder's rod proved satisfactory, and finally a large supply of scrapped yellow brass tubing of various sizes was found to give as good results as any material tried. This material was found to melt very easily and to be tough enough to hold the stone securely and yet be readily machined after being cast or brazed to the holder. A relatively large amount of flux was used to clean this metal, which had to be carefully skimmed, as some of the tubes were badly corroded. A small chip of clear pine will have a tendency to gather the slag and prevent it from leaving the crucible.

* * *

CLEARANCE OF BLANKING PUNCHES AND DIES

By A. EYLES

The clearance required between a blanking punch and its mating die is determined to a great extent by the thickness and kind of material to be cut. For thin material such as tin plate, the punch should be a close sliding fit in the die, as otherwise the punching will have ragged edges. For mild steel up to ⅛ inch in thickness, the punch should fit the die within 0.001 inch, and this clearance should be increased to 0.015 inch for material from ⅛ to 3/16 inch thick. However, if the diameter of the punch is less than twice the thickness of the material to be cut, a difference of 0.03 inch in the diameters of the punch and die is not too great to reduce the tendency of the punch to break off on being withdrawn from the die.

For aluminum, the angular clearance should be at least one degree on both the punch and die. Punches and dies for this metal should be carefully cleaned occasionally to remove the fine particles of aluminum that adhere to the edges of the tools, and the surfaces of the tools should be kept bright and polished. As aluminum is a soft metal, it clings tightly to the punch, and unless the surface is smooth, difficulty in stripping off the work is likely to be met with. The use of a good lubricant has an important effect on the appearance of finished articles. For deep-drawing tools a cheap grade of vaseline or lard oil is recommended, but for blanking, stamping, and shallow-drawing tools a thinner lubricant, such as paraffin, is preferable.

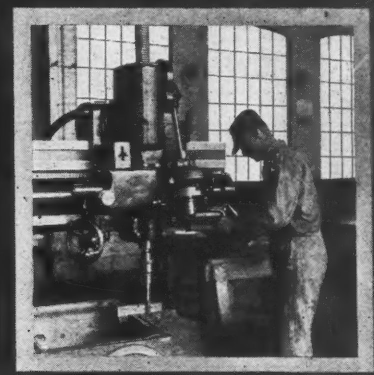
* * *

CAUSES OF INCREASED PRODUCTION

We have been able to add to our standards of living by the more general distribution of many articles that were either altogether luxuries ten years ago, or luxuries to a large portion of the population. Thus an increased proportion of the population are using electric lights, telephones, automobiles, and better housing. A rough estimate would show that we could today supply each person with the same amount of commodities that he consumed ten years ago, and lay off about 2,000,000 people from work. Some people have looked upon these additions of new commodities and services in the daily expenditure of our people as representing extravagances, but as a matter of fact they are no entrenchment upon savings. They are the product of better organized effort, of increased skill, and of the advancement of science; they are due to temperance, to the improvement of processes, and labor-saving devices—but most of all to the tremendous strides made in industrial administration and commercial organization by the elimination of waste in effort and materials.

Nor has all this been accomplished by imposing increased physical effort upon our workers. On the contrary, actual physical effort today is less than ten years ago. There has been in this period a definite decrease in the number of hours' work weekly, with a definite decrease in physical effort due to improved methods. Nor has it been accomplished by any revolutionary discovery in science. It is the result of steady improvement in management and method all along the line. It is an accumulation of better practice in the elimination of waste. It is a monument to the directing brains of commerce and industry and the development in intelligence and skill of the American workingman. The result has been a lift in the standard of living to all of our people—manual worker and brain worker alike. This is the real index of economic progress.—*Herbert Hoover*

Letters on Practical Subjects



DIE FOR CLINCHING CLIPS OVER WIRES

In the manufacture of novelties, it is considered good practice to handle as much of the work as possible on a punch press. The simple action of tripping the press will usually result in performing an operation much quicker than it can be performed in any other way. If only a few thousand parts are to be made, however, the cost of the die might easily offset the gain in production. The die shown in Figs. 1 and 2 was designed for use in assembling a novelty that was made up in large quantities, and the expense incurred in constructing the die was therefore of minor importance.

This job required the clinching of a pair of clips, such as the one shown at *W*, Fig. 1, over a wire *X*. The clips are driven through the cardboard *D*, after which the wires are put in place between the clips and the latter clinched over the wires by means of the die shown. The section of cardboard *D* at the left of the die has one clip *W* clinched in place. It is necessary to locate accurately the assembly of the cardboard and clips in the die for the clinching operation. This is accomplished by means of the stop or guide arrangement supported at *Y*, Fig. 2.

The die-holder *A*, Fig. 1, is fitted with a steel block *B* which has a groove cut in it that conforms to the radius of the clip after it is clinched over the wire. In Fig 1, the ends of the clip *W*, which is in place on the clinching die, are shown as they appear before being formed over the wire. The cardboard *D*, which contains the clips, is placed over the supporting plate *E*, with the clips between the fingers *F*. It will be noted that there is a punch-holder *G* carrying a blade *H*, the lower end of which is formed to a radius that corresponds with the outside surface of the clinched clip. The holder *G* is held in the ram of the press in the usual manner. On the frame of the machine are mounted brackets *J* which hold a cross-piece *K*. This cross-piece carries the two fingers *F* which are suspended on pivot-pins *L*.

Over the cross-piece *K* is placed a pair of blocks *N* and *P*. These have studs in their lower ends to which are attached springs *R* and *S*, which are, in turn, attached to the fingers *F*, thus normally holding the fingers open to permit sliding

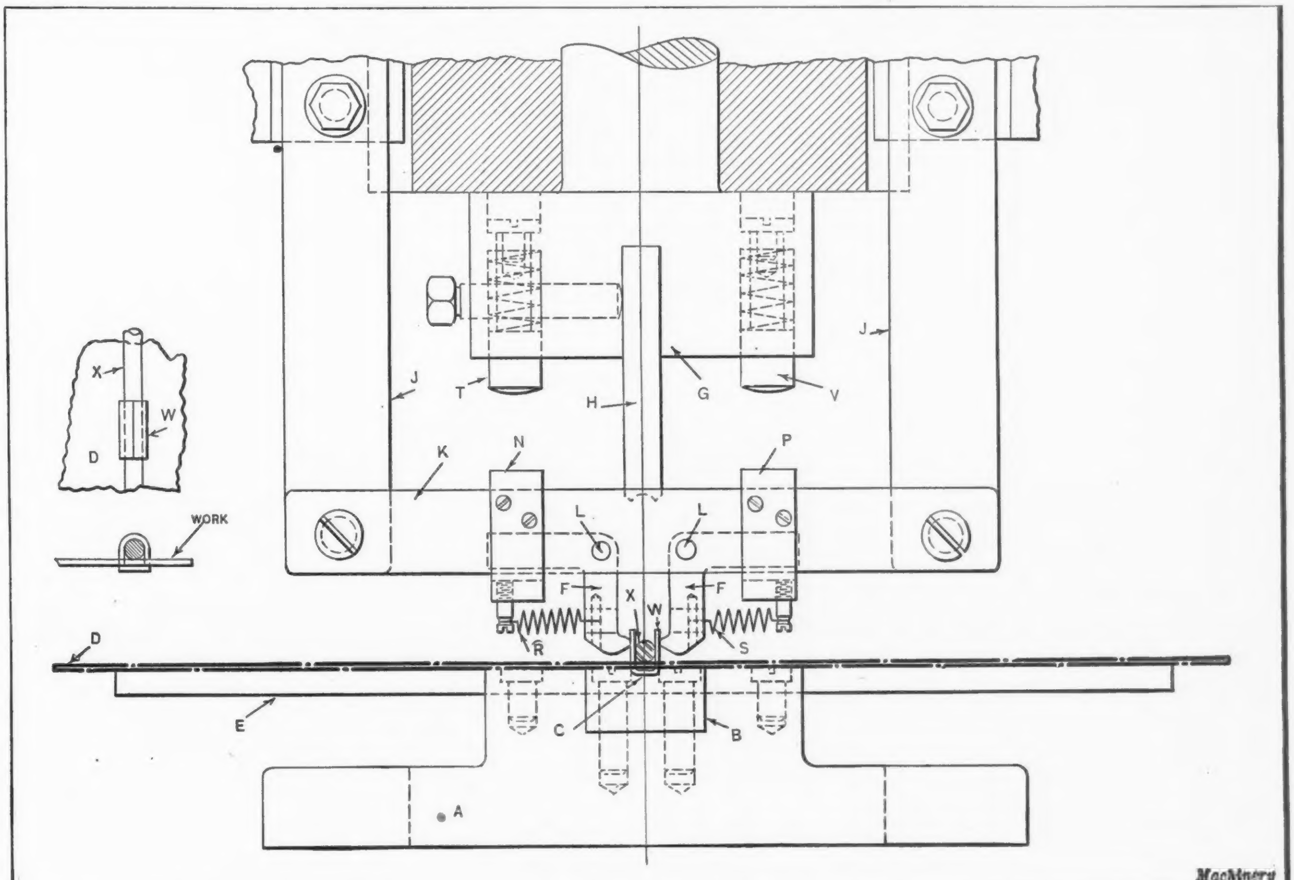


Fig. 1. Die employed to clinch Clips over Wires assembled on Cardboard

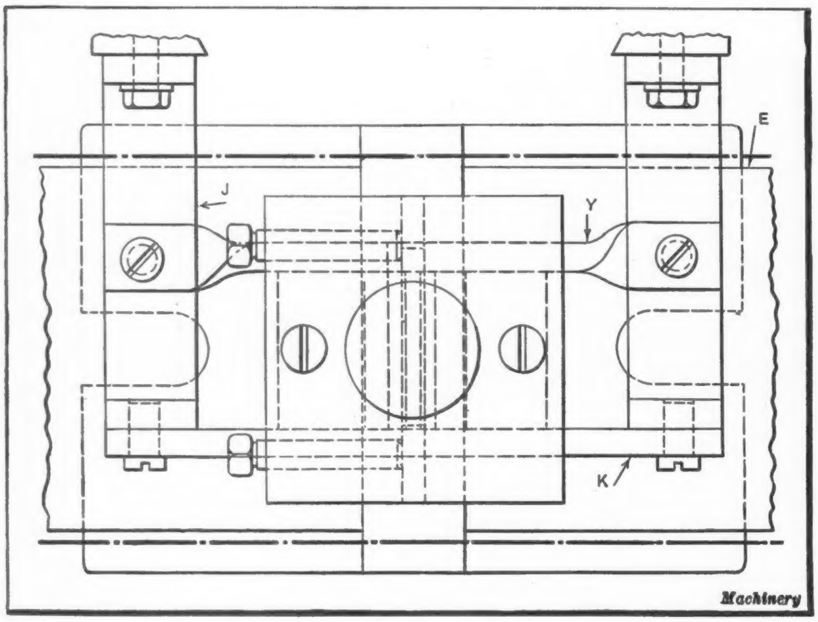


Fig. 2. Plan View of Die shown in Fig. 1

the work into place. After placing the cardboard *D*, with the clips and the wire in position, on the die, it is merely necessary for the operator to trip the press. As the ram of the press descends, two spring plungers *T* and *V* strike against the outer end of fingers *F*. These fingers, in turn, strike against portions of the steel clips and bend them over the wire. As the ram continues its downward stroke the springs in back of the pins *T* and *V* are compressed so that the punch *H* strikes the bent-over tops of the clips and clinches them over the wire. H. F. H.

REPAIRING A BROKEN PRESS FRAME

Recently the writer was confronted with the problem of repairing a broken press frame. The frame was cracked as indicated in the view at the left-hand side of the accompanying illustration. Although welding equipment was available, it was decided that it would be quicker to repair the frame by means of eye-bolts such as shown at *A*. There could be no doubt about the strength of the frame when repaired in this way, whereas the strength of a welded frame would be a factor of more or less uncertainty. As the press was urgently needed, an electric drill was put to work at once, drilling a hole through the frame of the machine under the lower jaw to receive the large bar *B* to which the eye-bolts were to be connected. In the meantime the heavy saddle *C* and the eye-bolts *A* were being forged.

The size of the eye-bolts was determined by the size of the largest bar that was to be sheared by the press. It was simply a matter of calculating the shearing strength of the material to be cut and then making the eye-bolts large enough to carry this load with a factor of safety of about 5 or 6. The pressure required to sever the largest bars to be cut, which were 1¼ inches in diameter, was calculated to be about 75,000 pounds. Therefore the eye-bolts had to be made strong enough to support this load at the point where the shear blades cut the bars. As the eye-bolts were some distance back of the blades, the leverage on the broken frame increased the load on the eye-bolts.

The actual amount of the load was then calculated by using the lever formula

$$P \times E = W \times F$$

where

P = pressure to be exerted, or, in this case 75,000 pounds; and

W = load on eye-bolts.

The value of F is found by subtracting dimension D (in this case, 5 inches) from dimension E (24 inches). Thus $F = 19$ inches. Substituting the values given, in the foregoing formula, we have:

$$75{,}000 \times 24 = W \times 19 \text{ or } W = 95{,}000 \text{ pounds}$$

Taking 12,000 pounds to the square inch as a safe load for the eye-bolts, it was determined that the bolts should have a cross-sectional area of 8 square inches. As there were to be two bolts, each would have an effective area of approximately 4 square inches.

From a table giving the areas of U. S. standard threads at the bottom of the thread, it was found that a bolt 2¾ inches in diameter has an area of 4.62 square inches. As there was sufficient space, it was decided to use 3-inch bolts in order to reduce the distortion of the press frame when subjected to the heavy load. The bar *B* is subjected to a bending strain and not a simple shear load, so that its size was determined by the use of the beam formula

$$Z = \frac{XG}{12{,}000}$$

in which

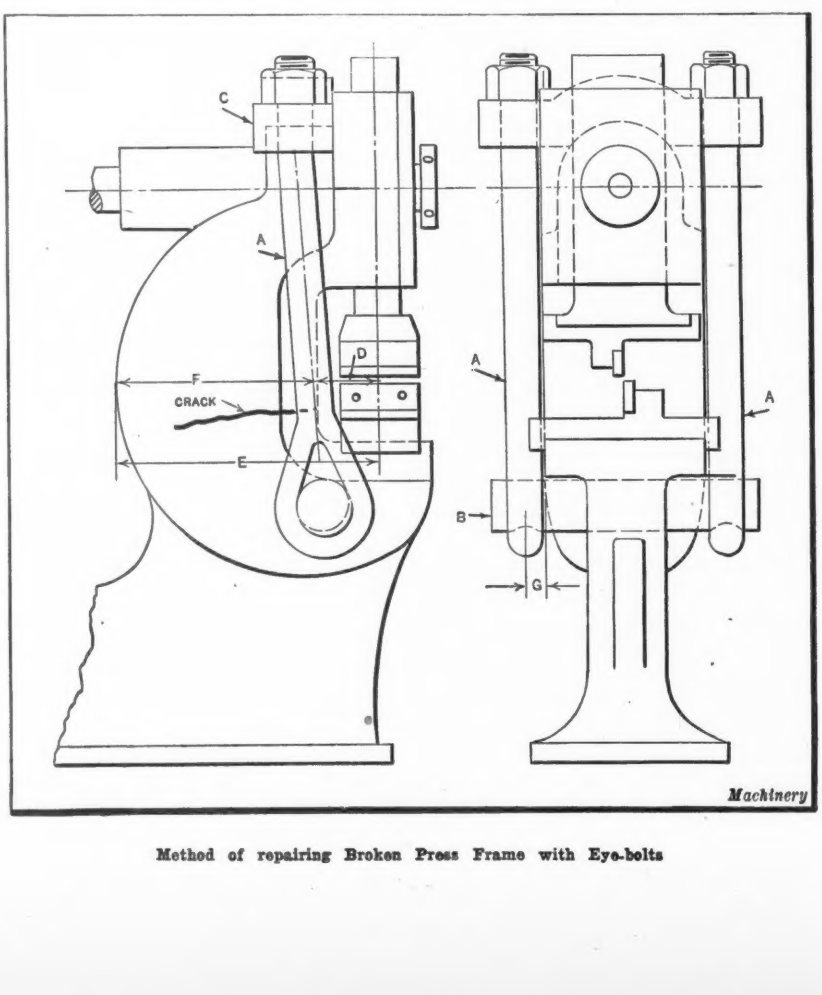
Z = section modulus of bar;

X = load in pounds (which, in this case, is 47,500 or one-half the total load); and

G = distance from bearing point of eye-bolt to edge of frame; as the eye-bolts were brought up close to the frame, the factor G, in this case, is 2 inches.

Then

$$Z = (47{,}500 \times 2) \div 12{,}000 = 8 \text{ approximately}$$



Method of repairing Broken Press Frame with Eye-bolts

In a table giving the section moduli, it was found that the next largest size of bar corresponding to this section modulus was 4½ inches in diameter. As the saddle *C* was required to carry about the same load as the bar *B*, it was made 4 inches high and 4 inches wide. This gave a total sectional area of 16 inches, which was equivalent to the area of the bar *B*.

Memphis, Tenn. JAMES ELLIS

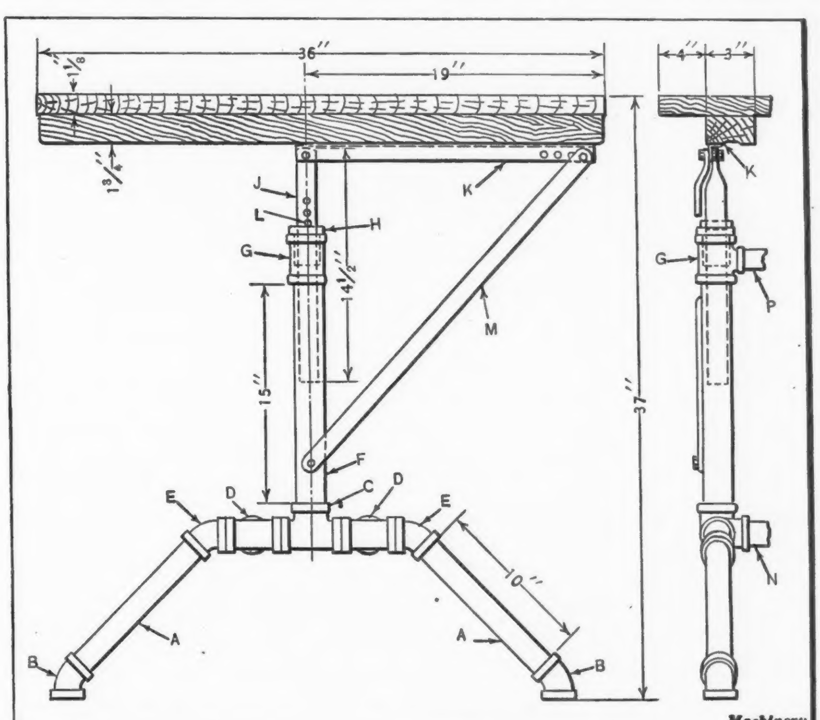
ADJUSTABLE DRAWING TABLE

The convenient drawing table here illustrated can be easily and cheaply constructed. The two end supports, one of which is shown in the illustration, are made up almost entirely of iron pipe and standard pipe fittings. The pieces *A* are made of 1¼-inch iron pipe. The 45-degree elbows *B* are threaded and secured to these pieces so that their open ends rest squarely on the floor. The upper ends of pieces *A* are connected with a 1¼- by 1¼- by 1½-inch tee *C* by close nipples, tees *D* and 45-degree elbows *E*.

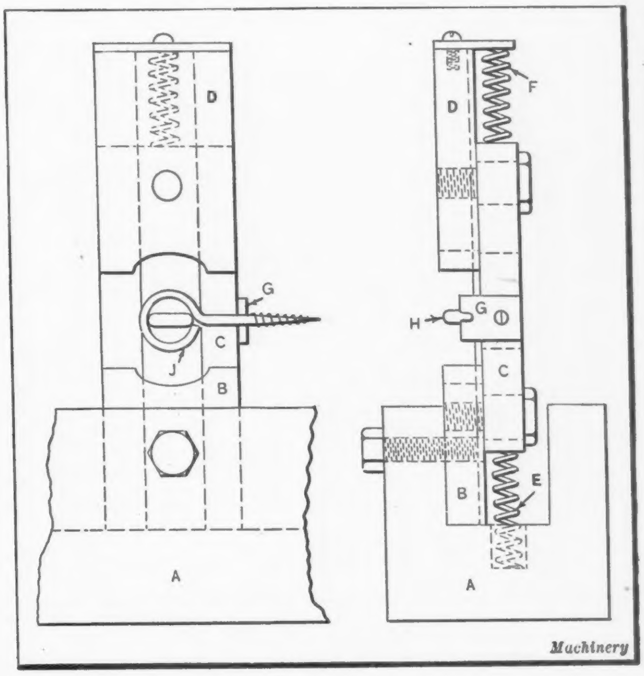
A piece of 1½-inch pipe *F* is tightly screwed into tee *C* in a vertical or upright position. To the upper end of pipe *F* is fitted a 1½- by 1½- by 1-inch tee *G*. The bushing *H* is fitted into the upper end of tee *G*. The hole bored in this bushing is a good sliding fit for the piece of 1-inch pipe *J*, which is attached to the angle-iron *K* by a ⅜-inch bolt. Several evenly spaced holes are drilled through piece *J* to receive a ⅜-inch pin *L*. This pin prevents the piece *J* from sliding down inside pipe *F*, and the different holes in the pipe provide for adjusting the table to different angles.

The brace *M* is made from a piece of ¼- by 1-inch flat iron and is secured to pieces *F* and *K* by ⅜-inch bolts. It will be noted that several holes are drilled through the outer end of angle-iron *K* as a further provision for adjusting the position of the table. The supporting frame at the other end of the table is a duplicate of the one shown. The two end supporting frames are joined together by two pieces of 1¼-inch iron pipe *N*, threaded right-hand on one end and left-hand on the opposite end to match fittings *D*, and by a piece of pipe *P* also threaded right- and left-hand on the ends to fit tee *G*. The length of these connecting pieces of pipe depends, of course, on the width of the drawing board, which may be made to suit requirements.

West Fitchburg, Mass. JOSEPH E. FENNO



Adjustable Drawing Table with Supports made from Pipe Fittings



Forming Die for Oval-shaped Screw-eyes

DIE FOR FORMING OVAL SCREW-EYES

A large number of round screw-eyes were required to be formed to an oval shape. As it was necessary to complete the work as quickly as possible, it was decided to use a punch press. The accompanying illustration shows the press tool or die which was made for the job. The plate *B* is screwed to the die-bolster *A*. Plate *C* is fastened to plate *B* by a stud which passes through a slot, this arrangement permitting a sliding movement of part *C*. Plate *D* is fastened to plate *C* in the same manner. A tongue on plate *C* fits into grooves cut in plates *B* and *D* so that these three members are kept in alignment.

Plates *C* and *D* are held in their extreme upper positions by springs *E* and *F*, respectively. Plate *C* is equipped with an oval pin *H* and a guide strip *G* which assists in locating the work in the die. The working faces of plates *B* and *D* are cut out to the required shape. In operation, the round screw-eye *J* is placed in the position shown, and the descending ram of the press strikes plate *D*, which is carried along until it touches the screw-eye. The motion is then imparted to plate *C*, which descends until the screw-eye touches plate *B*. Upon continued movement of the ram the screw-eye is pressed into an oval shape.

Philadelphia, Pa. R. H. KASPER

CUTTING AND FLANGING SHEET-STEEL DISKS

A machine for cutting and flanging sheet-metal disks for the wheels of tractor trailers is shown in the accompanying illustrations. It will be noted that the frame of this machine is built of structural steel members. The rotary shears, consisting of two cutting rolls *A* and *B*, Fig. 1, are capable of cutting sheet steel of any thickness up to ⅜ inch. One of the disks, as it appears after being flanged and drilled, is shown at *C*. The sheet steel from which the disk is cut is supported on the steel plate *D*, Fig. 2, and revolved about a center pin while it is being cut to the desired size by the rolls *A* and *B*.

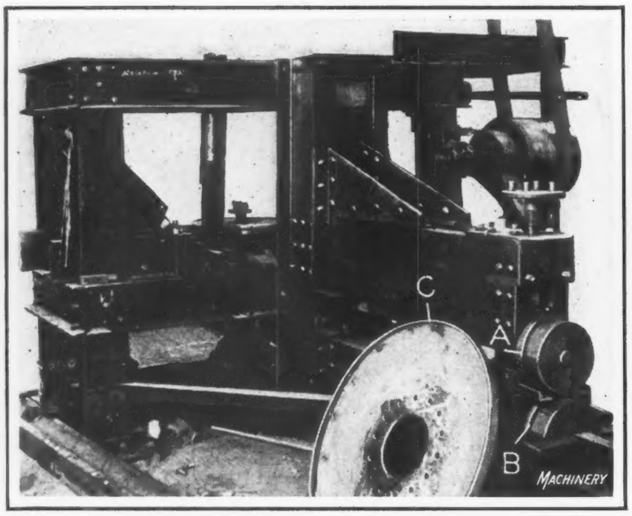


Fig. 1. Machine for cutting and flanging Disks for Trailer Wheels

After the disk is cut out, it is placed on the circular table *E*, for the flanging operation. The flange is turned down by means of two rolls *F* and *G* at opposite sides of the table. The axis of one of the rolls is parallel with the axis of the table, while the other roll is set at an angle of 45 degrees. After the disk has been secured to the circular table, two hinged arms, one of which is shown at *H*, are brought down over the work and clamped in place. Each of these arms is fitted with two rollers which bear against the work at points directly over the flanging rolls so that the disk will not be bulged or forced upward during the flanging operation. The table on which the work is mounted is driven by powerful gearing, and means are provided for adjusting the pressure exerted on the disk by the flanging rolls. The machine described is part of the equipment used by the Reliance Trailer & Truck Co., of San Francisco, Cal., in making disk wheels for their four-wheel trailers, some of which have a capacity for hauling twenty tons.

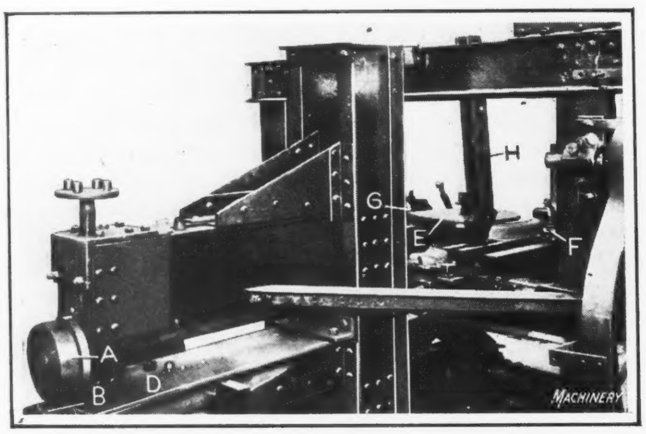


Fig. 2. Right-hand Side of Disk Cutting and Flanging Machine

San Francisco, Cal. CHARLES W. GEIGER

BENDING AND FORMING SHEET-METAL PARTS

In ordinary practice the majority of bends can be readily secured with any of the following sheet metals, provided the metal has the right temper: Aluminum, brass, copper, iron, black and galvanized steel, tin, terne, and zinc. There are a few well-defined rules applicable to all shapes and sizes of parts which, if carefully followed, will result in a first-class product with the metal unimpaired. The majority of sheet metals possess the property of flowing; that is, parts can be formed with the thickness of the metal to a large extent retained, but the molecules are worked to different positions, or, in other words, rearranged. That this occurs in forming an article by press tools is well shown when a perforated spherical bowl or cup is pressed from a flat sheet. Some of the perforations are enlarged and others contracted, according to the flow of the metal in the die.

Bending and forming dies for aluminum sheets should have all friction surfaces very smooth and polished in the direction in which the metal flows in the die. The number of press operations required to produce a given size of bowl or cup from aluminum is exceptionally small. It is not unusual to draw in one operation from a flat blank of medium stock, a cup whose length is equal to its diameter, and subsequent reductions in diameter may be effected in a similar intensive degree.

Blanking dies for aluminum parts may be made of cast iron and provided with a hardened steel insert, and the punch may be made of tool steel and left soft. The sheet metal itself is so soft in comparison with the punch that the considerable cost reduction obtained by omitting the hardening process is not offset by too short a life. Drawing dies and punches for aluminum parts should be made from hardened tool steel. When ordering sheet metals it is necessary to specify the temper desired, because most metals can be obtained in various grades of hardness ranging from dead soft to dead hard. The finish should also be specified, whether dead-flat, open-annealed, planished or tinned. Care should be exercised to specify the sizes of sheets best adapted for the work to be produced.

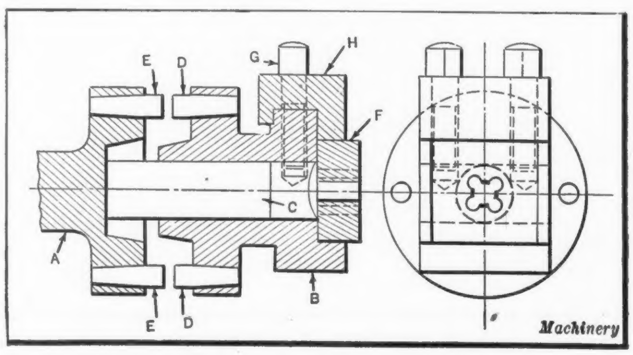
Manchester, England A. EYLES

HOLDER FOR THREADING DIE

A releasing holder for threading dies of the solid or non-opening type, is shown in the accompanying illustration. This holder is designed for use on turret lathes, and consists primarily of a shank *A*, made to fit the holes in the lathe turret, and a die-holding member *B*, which is a good running or sliding fit on the projecting end *C* of shank *A*.

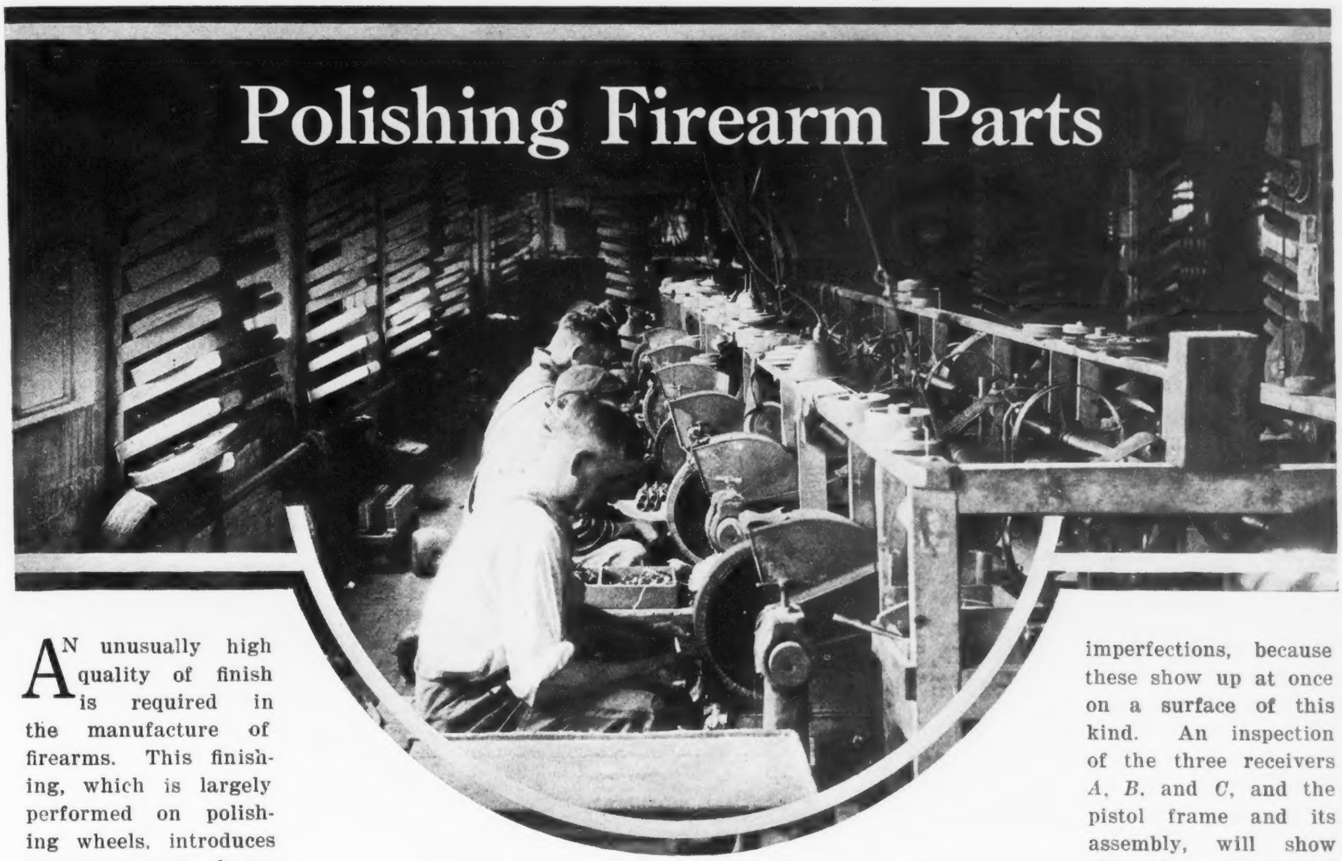
The threading die *F* is clamped in place by tightening nuts *G* on jaw *H*. When the piece to be threaded comes in contact with the die, the holder is pushed back on end *C* so that the pins *D* make contact with the pins *E* in shank *A*. Thus the holder is prevented from being rotated while the work is fed through the die the required distance. When the feeding movement is stopped, the rotation of the threaded work in the die causes the holder to be drawn out on the end *C* of shank *A* until the pins *D* and *E* are no longer in contact, and holder *B* then revolves with the work. The spindle is next reversed and the shank *A* advanced to stop the rotation of holder *B*, so that the threaded work is unscrewed from the die. For threading small work, only two pins *E* are required in shank *A* and two mating pins *D* in the die-holding member, but for large stock, more pins may be required. These pins are driven into tapered holes, and thus may be easily replaced when worn.

Chemnitz, Germany TH. R. WAGNER



Releasing Type of Holder for Non-opening Threading Dies

Polishing Firearm Parts



By BRADFORD H. DIVINE,
President Divine Bros. Co., Utica, N. Y.,
and President of the Metal Finishers' Equipment Association

AN unusually high quality of finish is required in the manufacture of firearms. This finishing, which is largely performed on polishing wheels, introduces two important phases of the polishing industry, namely, the finishing of contours and intersecting planes, and operative skill in maintaining these lines of design. Probably there is no other single industry in which the finishing by polishing requires more expert workmanship, because such parts as rifle receivers and pistol frames, bolts, and breech plugs are designed with certain outlines which, for the sake of appearance, must be preserved. If this is not done, the sale of the firearms is materially affected.

It is well known that guns and rifles are sold largely from the show-case and the display window, and it does not take much of a deviation from the established lines of design to give the article an appearance which often prevents the sale. The polishing of firearms is an intricate operation, because nearly every exterior surface on these parts must be polished, and the design does not lend itself readily to all kinds of wheels. The practice followed in the plant of the Savage Arms Co., Utica, N. Y., in finishing certain parts of firearms, is described in this article.

In Fig. 1 a collection of firearm parts is shown. In the hexagon rifle barrel, it is obvious that the parallel lines must be exactly maintained, and must not be wavy to any degree. Also, the round barrel must contain no flats or other imperfections, because these show up at once on a surface of this kind. An inspection of the three receivers *A*, *B*, and *C*, and the pistol frame and its assembly, will show the importance of maintaining the lines of design, for these parts, when assembled in the fire-pieces must present a well matched appearance. It should be noted that these parts are finished all over by profile milling before any polishing is attempted. For this reason fewer polishing operations are necessary than would otherwise be required for work of this quality.

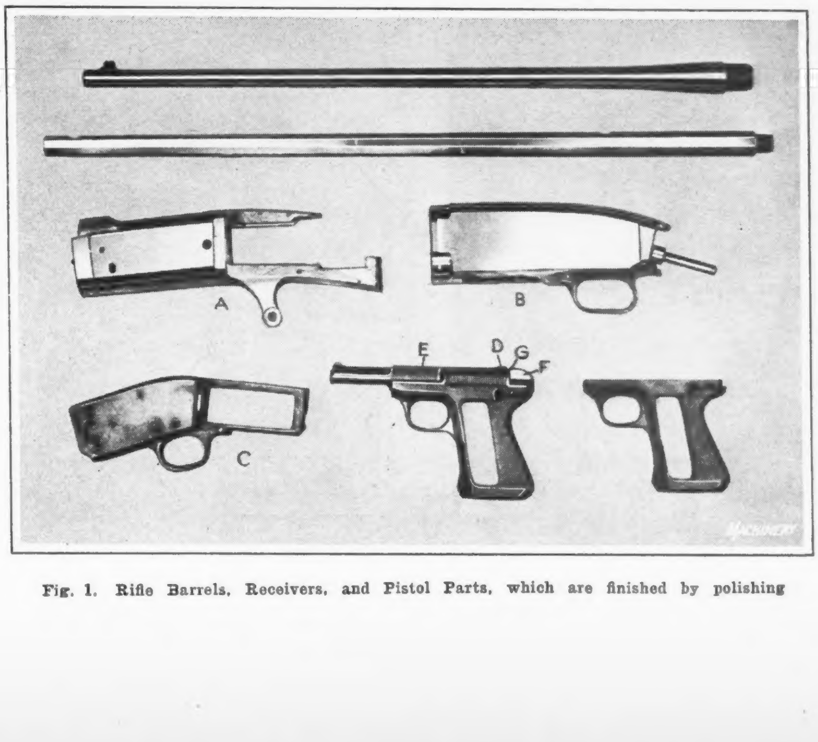


Fig. 1. Rifle Barrels, Receivers, and Pistol Parts, which are finished by polishing

Polishing Rifle Receivers

The important finishing operations on the receiver *A* may be regarded as representative of those performed on the other two receivers. Whatever differences occur are in the diameters of the wheels to fit surfaces of different radii, or in the shapes of the wheel faces to fit the contours of particular parts, rather than in the character of the operations. The abrasives used are, in general, as follows:

Operation 1: Flexible grinding with No. 70 TJ alundum.

Operation 2: Roughing with No. 120 TJ alundum.

Operation 3: Greasing with No. 150 TJ alundum.

Operation 4: Fine greasing with FF emery.

Operation 5: Coloring with FF emery.

The wheels used are about 16 inches in diameter, operating at a peripheral speed of 7500 feet per min-

ute, except where smaller wheels are necessary for surfaces that cannot be reached by those of larger diameters. The abrasive heads on the wheels in the first three operations are rolled on, while in operations 4 and 5 the wheels are set up with paste heads, except for the plugs and wheels of small diameter, which are always set up with rolled heads.

Flexible grinding operations for the flat sides and the top and bottom convex surfaces of the receiver may be performed on a flat-faced leather-covered wood wheel, or on an extra-hard one-inch cushion compress leather wheel; but operations 2, 3, 4, and 5 are performed on flat-faced compress leather wheels having 2-inch cushions of medium density, with either flat or formed faces to fit the surfaces to be polished. Exceptions to these rules are found in the polishing of the sides of the finger lever lug of receiver *A*, which has to be done with a wheel of about 8 inches diameter, because the 16-inch wheel is too large to reach the surface without interfering with other parts of the receiver. This wheel is made of compress walrus, solid walrus, or Spanish felt, having a formed face to fit the surface. The polishing operation on this part is shown in Fig. 5. Other exceptions are found in polishing such surfaces of the trigger guards as in receivers *B* and *C*, Fig. 1, and connecting surfaces of small radii, etc. In these operations walrus plugs secured on the ends of spindle points are used as shown in Figs. 10 and 11.

Fig. 2. Polishing the Top and Bottom Round Sections of the Receiver

Fig. 2 shows the method of holding the receiver against the wheel in polishing the top and bottom round sections. Fig. 3 shows the type of wheel used, and the method of holding the receiver in position for polishing the flat sections. Fig. 4 shows the formed-face compress leather wheel used for polishing the convex surface on the top of the front end of the receiver into which the barrel is screwed. Fig. 6 shows the method of polishing the front concave side of the finger lever lug on a formed compress leather wheel. Fig. 7 shows the method of holding the receiver in polishing the rear concave surface of the finger lever lug on a formed compress leather wheel. In performing the greasing and fine greasing operations 3 and 4, emery cake is fed to the wheel face. This cake is made by melting twenty-five parts of beef tallow and one part of beeswax, and stirring in enough FF emery flour to make a thick paste, which is cast into molds of convenient size and allowed to harden.

Fig. 3. Polishing the Flat Sides of the Receiver with a Flat-faced Compress Leather Wheel

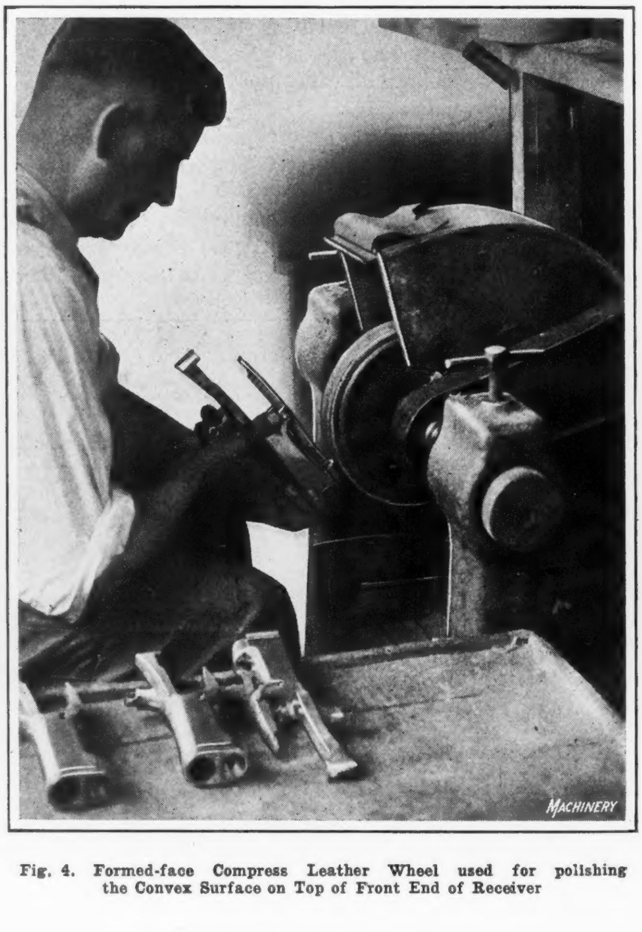


Fig. 4. Formed-face Compress Leather Wheel used for polishing the Convex Surface on Top of Front End of Receiver

For the last or coloring operation, wheels are used on which the abrasive heads have been thoroughly broken down or smoothed by previous use, so that they present much smoother polishing surfaces than can be obtained by any freshly applied abrasive of any size. This smooth condition is further improved by dressing the wheels, or "stoning" them, with flint or some other good hardening stone.

Polishing Rifle Barrels

The illustrations Figs. 8 and 9 show the manner of handling rifle barrels while polishing. This work is done on flat-faced compress leather wheels, about 16 inches in diameter by 3-inch face, with 2-inch cushion, of medium density, operating at a speed of 7500 peripheral feet per minute. The round rifle barrel is spun by being held against the face of the polishing wheel. It is supported in a notched piece of wood held on the operator's knee with one hand, while the other hand, protected by a pad, regulates the speed of the barrel and guides it across the face of the polishing wheel at the proper angle. Three operations are required in finishing this part—roughing with No. 90 alundum, dry-fining with No. 120 alundum, and greasing or finishing with No. 150 alundum. In the third operation the polishing wheel is greased with cut cake made of emery flour, beeswax, and suet, as described in connection with the receiver operations.

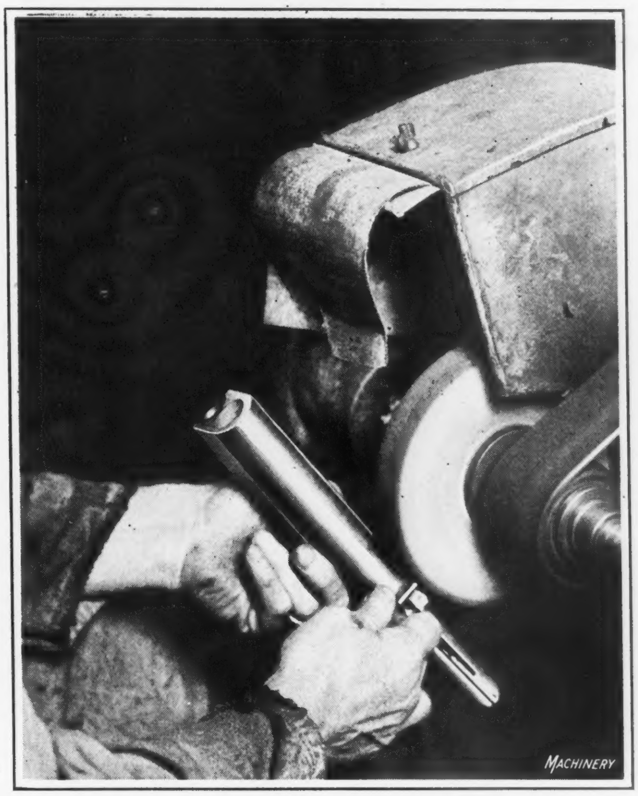


Fig. 5. Polishing the Sides of the Finger Lever Lug of the Receiver

Fig. 9 shows the method of holding the hexagonal rifle barrel in contact with the polishing wheel. The same size and type of wheel is used as in polishing the round barrels. The number of operations and sizes of the alundum grain are also the same. The requirement that every flat surface in the barrel shall be absolutely flat and that the corners shall be absolutely straight and sharp requires a wheel that will run perfectly true. It will be realized that these operations require extreme precision and delicacy.

Polishing Pistol Parts

An assembled pistol consists of a frame, bolt, and breech plug, all the exposed parts of which are polished. The operations on these parts are as follows:

Operation 1: Roughing with No. 90 TJ alundum.

Operation 2: Dry-fining with No. 120 TJ alundum.

Operation 3: Greasing with No. 150 TJ alundum and beef tallow.

Operation 4: Coloring with No. 150 TJ alundum and cut cake.

The same type of compress leather wheel as is used for the rifle parts is employed for polishing pistols, the faces being flat or formed to fit the surfaces of the parts being polished. In polishing the pistol frame, the inside and outside of the trigger guard, and the adjacent surfaces on the body where larger wheels cannot be used, are polished with walrus plugs, as shown in Figs. 10 and 11. These plugs, or rolls, are from ¾ to 2 inches in diameter, depending upon the work, and the speed is approximately 2100 revolutions per minute. The same four operations, using the same size of alundum grain, beef tallow, and cut cake, are required as in polishing the other parts.

The sides of the pistol frame are polished on leather-covered wood wheels or on compress leather wheels, about 14 inches in diameter by 2½-inch face by 2-inch cushion, of extra hard density. The working speed is 7500 peri-

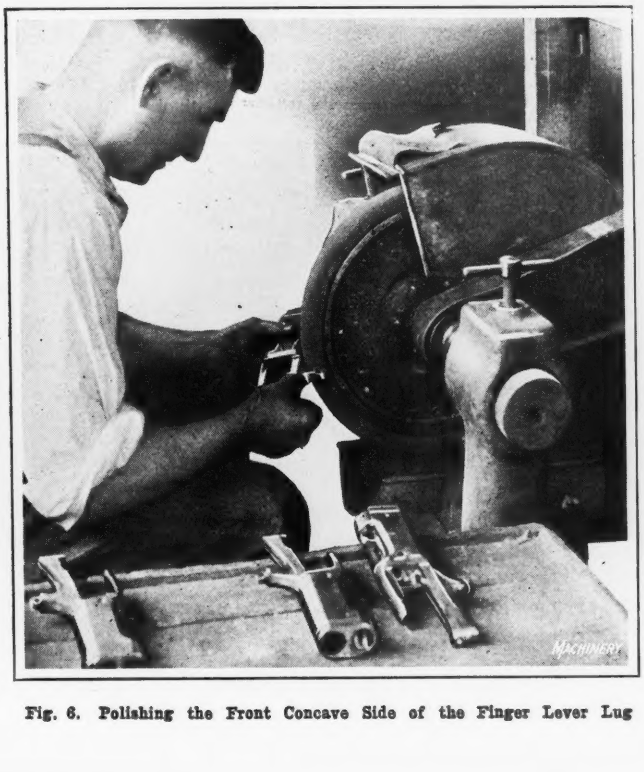


Fig. 6. Polishing the Front Concave Side of the Finger Lever Lug

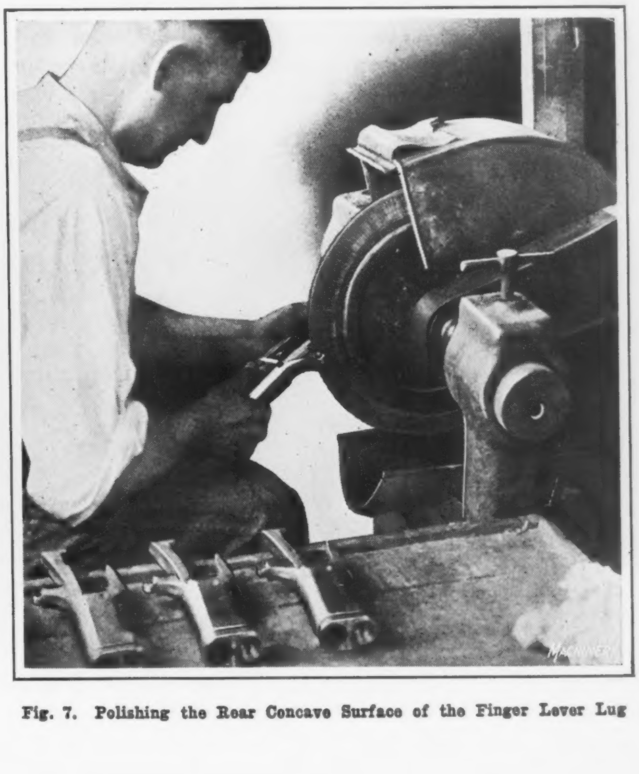


Fig. 7. Polishing the Rear Concave Surface of the Finger Lever Lug

Fig. 8. Polishing Round Rifle Barrels

Fig. 9. Polishing Hexagon Rifle Barrels

pheral feet per minute. This operation is illustrated in Fig. 13. This wheel has rounded corners, so that the upper curved portion may be reached by the wheel.

The same operations are used in finishing the bolt as are employed for the frame. A concave-face, compress leather wheel, of medium density, which fits the surfaces at each side of the rear sight *D*, Fig. 1, is used, after which a compress leather wheel, with the face formed to fit the contour, is used for the remainder of the large diameter of the bolt. There are two flat surfaces on the sides of the bolt, one of which is shown at *E*, which are polished with plugs like those used for finishing the inside of the pistol trigger guard; by this means the fillets and edges are kept uniform, and the general appearance is not affected. The cylindrical end of the bolt is polished by spinning on a polishing wheel in the same way as the round rifle barrels are finished. This operation is performed on a leather-covered wood wheel or a compress leather wheel of hard density.

The front sight is inserted after the cylindrical part of the bolt has been polished, and is then polished on the same wheels. Breech plug *F* has a cross section which is T-shaped, and the concave surfaces in each side of the dividing wall are polished in two operations on a speed lathe, using Nos. 90 and 150 emery cloth wound around a slotted piece of steel. There seems to be no other practical way by which these recessed surfaces can be reached. The top of flange *G* and the adjoining web are polished on three leather-covered wood wheels, set up with No. 120 alundum, No. 150 alundum, and FF emery, respectively. Beef tallow is applied to the wheels in operations 1 and 2, and cut cake in operation 3.

After the pistol frame, bolt, and breech plug are polished, they are assembled, and the adjacent curved surfaces of the plug and pistol frame at the rear are matched on polishing wheels. This is done in four operations on a leather-covered wood wheel or a hard compress leather wheel, as before, using No. 60, No. 120, and No. 150 alundum, and FF emery. The blending of these surfaces, as shown in Fig. 14, is done so perfectly that when the pistol is new it is often difficult to perceive that the metal is not all one piece. All of the operations described on both the rifle and pistol parts produce the highest grade of polish. If a cheaper finish is desired, the parts are sand-blasted after polishing operations 1, 2, and 3 have been performed. They are then steel-wire brushed and browned.

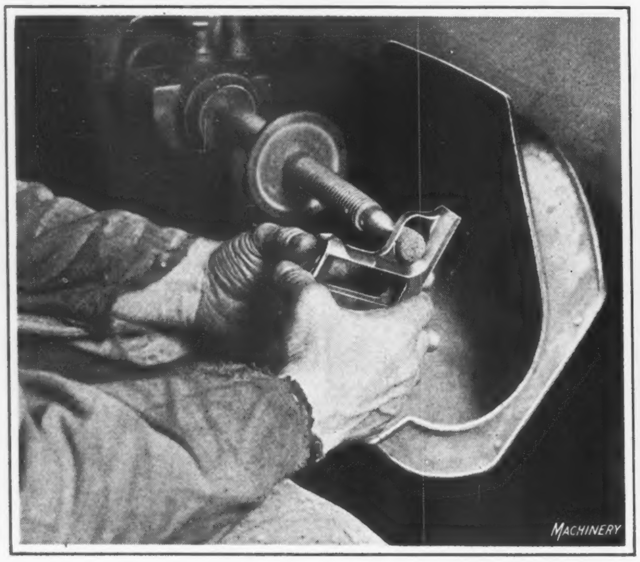


Fig. 10. Using Walrus Plugs for polishing Inside of Trigger Guard

Fig. 11. Polishing Exterior of Trigger Guard with a Walrus Plug

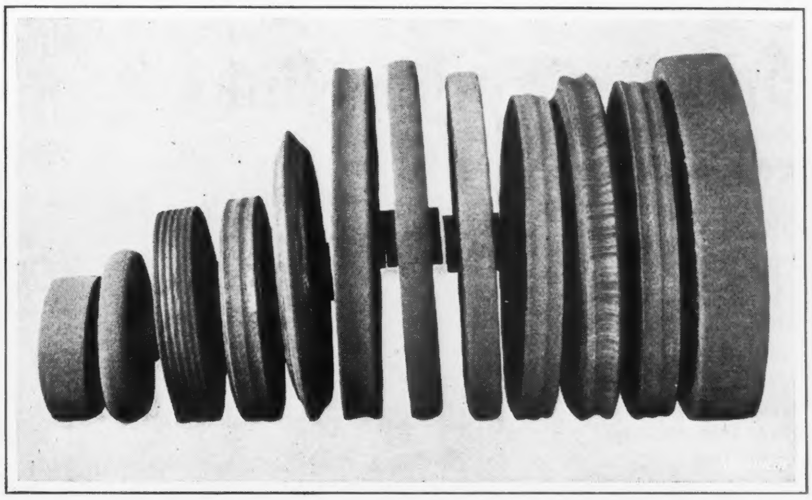


Fig. 12. Types of Wheels used in polishing Rifle and Pistol Parts

In Fig. 12 are illustrated a number of the compress leather wheels of various sizes, with both flat and formed faces, used for polishing rifle and pistol parts. Wheel No. 1 is a small flat-faced wheel for general use in polishing small parts; wheel No. 2 is a convex-faced wheel for polishing the sides of the finger lever lugs; No. 3 is a grooved-face wheel for polishing screw heads and similar small parts; Nos. 4, 9, and 10 are concave-faced wheels for polishing cylindrical or round surfaces; No. 5 is a formed-face wheel for polishing the back part of the finger lever lug; No. 6 is a concave-faced wheel for polishing the front top round section of receiver *A*, Fig. 1; wheel No. 7 is used for polishing the front of the finger lever lug; No. 8 is for general use; No. 11 is a concave-faced wheel for polishing rifle bolt knobs, the operation being shown in Fig. 15; wheel No. 12 is a flat-faced wheel for general use in polishing round and hexagonal rifle barrels. The heading illustration shows a bank of polishing machines polishing the parts mentioned.

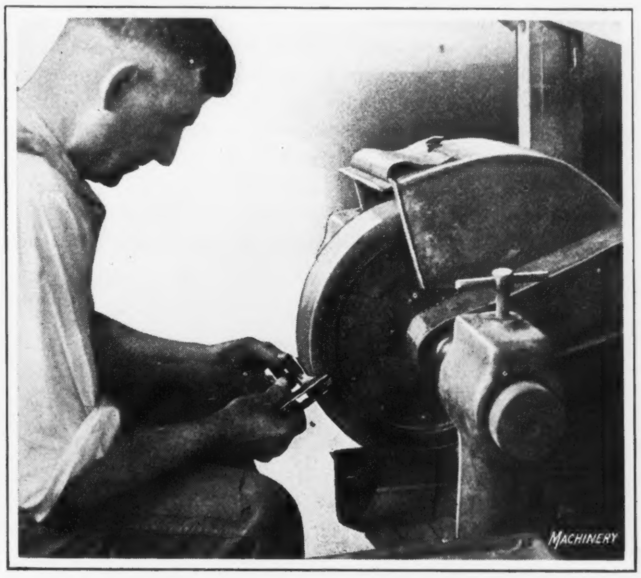


Fig. 13. Polishing Sides of Pistol Frames with Wheel having Rounded Corners to suit Curved Part of Work

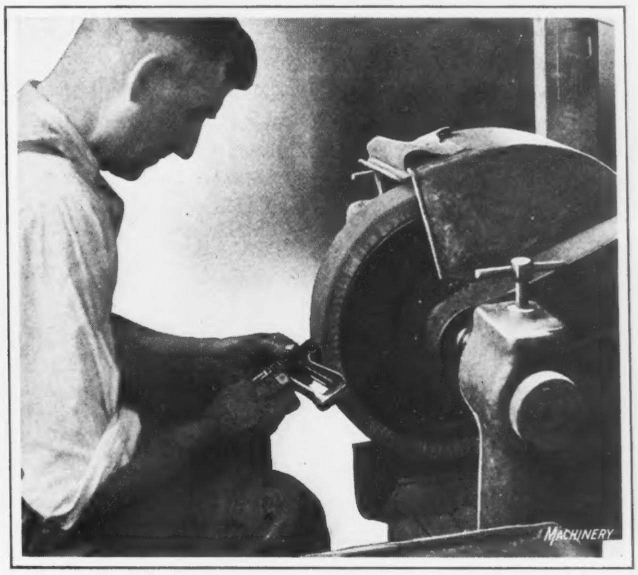


Fig. 14. Blending Adjacent Curved Surfaces of Pistol Frame and Breech Plug after assembling

* * *

NEW GEAR-TESTING DEVICE

The National Physical Laboratory of Great Britain has constructed a gear-testing machine with which it is possible to examine separately the six elements of a gear tooth—pitch, shape, thickness, concentricity with axis, radial symmetry and pitch diameter. The device will indicate errors of 0.0001 inch. The machine can also be used for obtaining a complete record of performance when two gears are running in mesh with each other.

INTERNATIONAL BALL BEARING STANDARD

At the international conference of secretaries of national standardization bodies, held in Zurich, Switzerland, during the summer, delegates from the United States, German, and Swedish sectional committees took part in a conference on ball bearings. A report was prepared which, although only preliminary, indicates that those present agreed on the diameters, widths, and corner radii for radial type bearings in the light, medium, and heavy series. If the extra wide type of radial bearings is needed by the foreign countries, the S.A.E. standards will be considered. A proposal is to be prepared for tolerances for bores, diameters and widths, the bore and diameter tolerances following approximately those proposed by the American Sectional Committee in March, 1922, and the width tolerances following the present Swedish practice. The latest German proposal for thrust ball bearings was recommended, extended to include both 600 millimeter diameter sizes and an extra heavy series, the tolerances for all diameters to be those for the radial bearings.

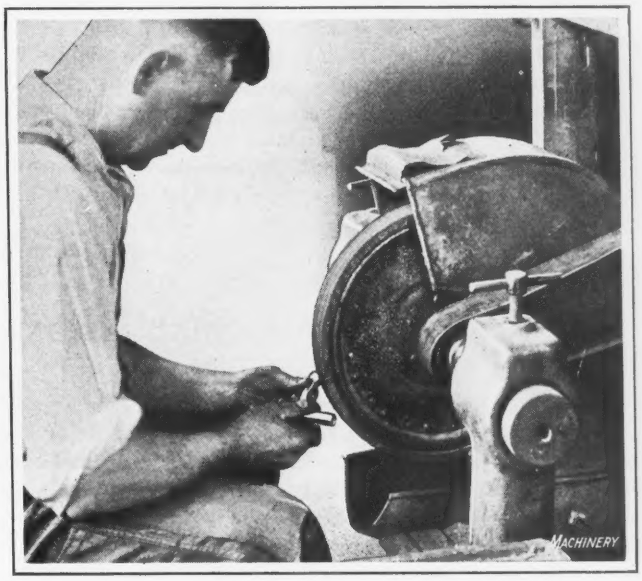


Fig. 15. Polishing Rifle Bolt Knobs

Shop and Drafting-room Kinks

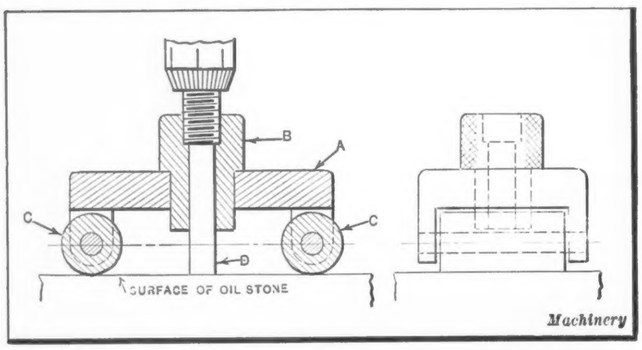
RESURFACING WORN OILSTONES

The problem of resurfacing oilstones to remove the hollows caused by continued use is one that has undoubtedly confronted most mechanics at some time. Grinding on an emery wheel will glaze the surface and destroy the cutting qualities of the stone. A method, such as described in the following, however, has been found to restore the stone to as good a condition as when new. An old bastard file is laid on the bench, and a small quantity of oil and coarse emery placed on it. The stone is then rubbed back and forth over the file with a slight pressure until the surface of the stone is straight. A straightedge or scale may be used to test the surface.

Takoma Park, D. C. G. W. NUSBAUM

FIXTURE FOR TRUING MICROMETER SPINDLE CONTACT SURFACE

The gaging or contact surfaces of micrometers that are used constantly for inspection work must be trued up occasionally so that the adjacent contact surfaces will be parallel with each other and at right angles to the axis of the spindle.



Fixture for truing Micrometer Spindle Contact Surface

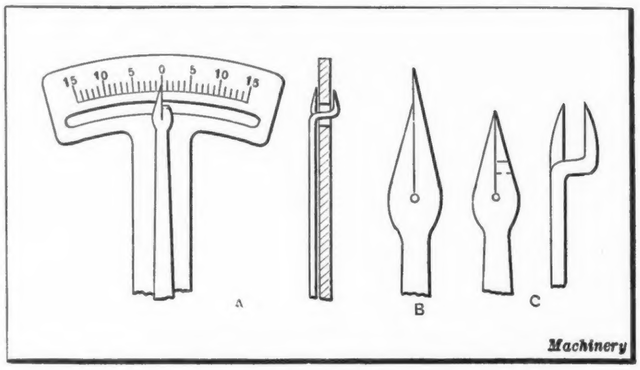
The fixture shown in the accompanying illustration provides a means of holding the micrometer spindle perpendicular to the trued surface of an oilstone while resurfacing the contact surface.

The fixture consists of a steel block *A* with a separate bushing *B* for securing the micrometer parts to the block, and two rollers *C* which are of uniform size and accurately mounted on the block *A* so that the spindle will be held perpendicular to the surface of the oilstone. The oilstone should be surfaced on a trued cast-iron block using fine sand and water as an abrasive mixture. The micrometer spindle *D* is placed on the tool as shown and stroked along the surface of the stone by rolling the block *A* back and forth.

Washington, D. C. G. A. LUERS

TEST INDICATOR WITH GRADUATIONS ON BOTH SIDES

A test indicator provided with two scales so that the operator can read the variations of the needle from either side of the instrument is often desirable. The pointer and scale of an indicator of this type which the writer made and used with satisfactory results are shown at *A* in the illustration. The scale head is slotted near its lower edge to allow the bent half of the pointer to pass through to the reverse side. The slot also limits the travel of the needle, thus making it unnecessary to provide guard wires, such as are generally used on standard indicators.



Test Indicator Scale that can be read from Either Side

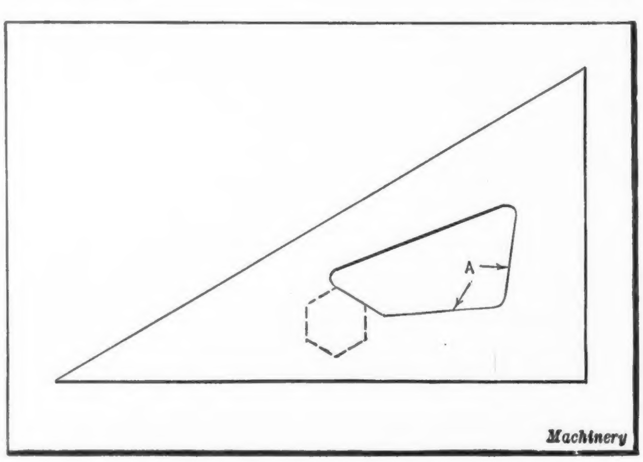
The double-pointed end of the needle is simple and of one-piece construction, being blanked out and split in the center, as shown at *B*. The longer end is bent as shown by the plan and side views at *C*. Both scales are made alike, and the pointer is carefully adjusted so that the same reading will be obtained on both sides. With this type of indicator, the operator is not required to walk around to the side of the machine in order to see the scale when the indicator is set in an unusual position.

Allentown, Pa. JOE. V. ROMIG

IMPROVED STYLE OF 30-DEGREE TRIANGLE

The writer has always wondered why manufacturers of draftsmen's triangles usually make the sides of the opening or hole in their triangles parallel with the corresponding outer edges. Why not adopt some other style of opening that would increase the usefulness of the triangles? Remodeled triangles are regularly used by many experienced draftsmen and designers that might be copied by the manufacturers. The triangle shown in the illustration, for instance, is designed so that all six sides of a hexagonal nut can be drawn without reversing the position of the triangle. In addition to this useful feature, the sides *A* are cut at an angle of 5 degrees with the corresponding outer edges of the triangle so that lines can be readily drawn at an angle of 5 degrees from the vertical or from the horizontal.

Ontario, Cal. J. HOMEWOOD



Triangle designed to facilitate drawing Hexagonal Nuts

Questions and Answers

DRAFTING-ROOM SYSTEMS

R. B. T.—I would be interested in a brief outline describing a system for filing preliminary drawings and layouts in a machine building plant. If anyone has devised such a system, its publication in MACHINERY would probably prove of value to many readers.

PROBLEM IN GAGE DESIGN

B. K. G.—Will you please give a solution to the problem in gage design appearing on page 984 of August MACHINERY, that does not involve the solution of a quadratic equation?

ANSWERED BY C. N. PICKWORTH, WITHINGTON, MANCHESTER, ENGLAND

Referring to the accompanying diagram we have,

$$AD = \cot 30 \text{ degrees} \times 1/32 = 0.054126$$
$$BF = 0.21875 - 0.054126 = 0.164624$$

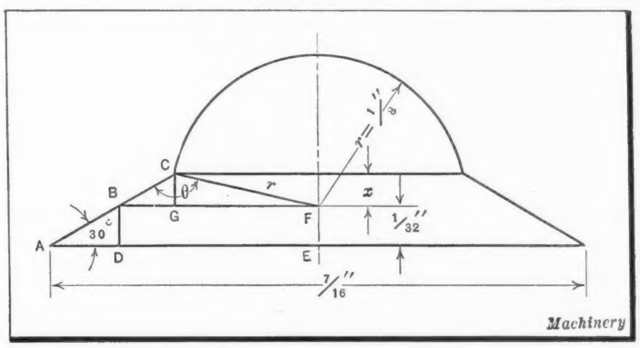


Diagram used in the Solution of a Gage Problem

$$\sin \theta = \frac{0.164624 \times \sin 30 \text{ degrees}}{0.125} = 0.658496$$

and

$= 41$ degrees 11 minutes or 180 degrees $-$ 41 degrees 11 minutes $=$ 138 degrees 49 minutes

As $BCG = 60$ degrees, the angle $GCF = 138$ degrees 49 minutes $-$ 60 degrees $=$ 78 degrees 49 minutes

and

$CFG = 90$ degrees $-$ 78 degrees 49 minutes $=$ 11 degrees 11 minutes

Now $CG = x = 0.125 \sin 11$ degrees 11 minutes $= 0.125 \times 0.193949 = 0.02424$ inch

FINDING RADIUS FOR DIE LAY-OUT

L. M. B.—The problem submitted by H. K. D. in December, 1920, MACHINERY, on page 379, has come up frequently for solution in our die department. The solution given with the problem as originally submitted cannot readily be applied by some of our workmen, as it involves algebraic calculations with which they are not familiar. If possible, will you please give a simple formula involving only mathematical calculations, which can be used for solving the problem as presented in the accompanying diagram? In the problem under consideration we have given dimensions a, b, and c, where $c = a + b$. It is required to find the radius r.

ANSWERED BY RONALD L. WAKELEE, TOLEDO, OHIO

By construction, we have $MN = c - a$. Substituting the equivalent value of c in this equation, we have $MN = a + b - a = b$. Now $LN = c - r$ or, by substitution, $LN = a + b - r$. The angle ϕ is common to triangles KLM and LMN so that in triangle KLM we have,

$$\cos \phi = \frac{(a + b)^2 + (a + r)^2 - (b + r)^2}{2\,(a + b)\,(a + r)}$$

and in triangle LMN

$$\cos \phi = \frac{b^2 + (a + r)^2 - (a + b - r)^2}{2b\,(a + r)}$$

Now as the member at the right-hand side of the sign of equality in each of the preceding equations is equal to $\cos \phi$ we have,

$$\frac{(a + b)^2 + (a + r)^2 - (b + r)^2}{2(a + b)} = \frac{b^2 + (a + r)^2 - (a + b - r)^2}{2b}$$

Expanding and reducing,

$$a^2r + b^2r + abr = a^2b + ab^2$$

Combining

$$r(a^2 + b^2 + ab) = ab(a + b)$$

Solving

$$r = \frac{ab(a + b)}{a^2 + b^2 + ab} = \frac{ab(a + b)}{(a + b)^2 - ab}$$

Now as $c = a + b$ we have by substitution,

$$r = \frac{abc}{c^2 - ab}$$

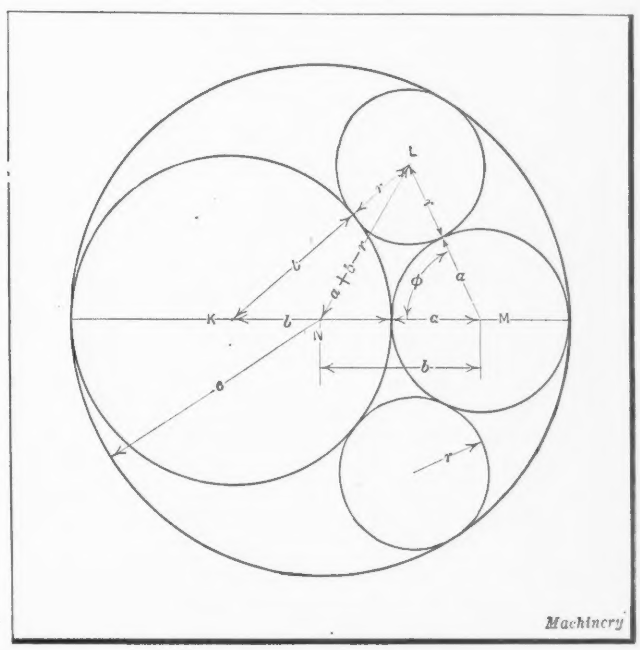


Diagram used in solving Die Problem

Then, for example, if $a = 1$, $b = 2$, and $c = 3$, we have

$$r = \frac{1 \times 2 \times 3}{3^2 - (1 \times 2)} = \frac{6}{7} \text{ or } 0.857 \text{ inch}$$

CROSS-SECTIONING OF DRAWINGS

A. L. R.—Should drawings be cross-sectioned only by lines running at 45 degrees, or is it permissible to cross-section also with 30- and 60-degree lines, in order to separate the cross-sectioned parts more clearly at a glance?

A.—There is no generally accepted rule for cross-sectioning, but usually cross-section lines are made at a 45-degree angle, section lines of 30- and 60-degree angles being less commonly employed. The opinions of draftsmen and designers are invited.

The Machine-building Industries

WHILE the machine tool business fell off to a considerable extent in the summer months, a fair improvement has been noticeable during September in most parts of the country. Several machine tool builders had quite an encouraging number of inquiries, some of which materialized into orders. Automobile plants, locomotive-building shops, the larger electrical plants, and the railway supply manufacturers have been most active in the market. Nevertheless, the expectations for an active fall business in machine tools have hardly materialized as yet. Although a marked increase in business is not expected for the remainder of the year, indications point to an improvement over the present level.

Foreign trade in machine tools shows a gradual improvement. In July, the last month for which complete statistics are available, the value of different types of machine tools exported was as follows: Lathes, $97,000; grinding machines, $87,000; boring and drilling machines, $67,500; turret lathes and screw machines, $28,000; planers, shapers, and slotters, $32,000; gear-cutting machines, $20,000; power presses, $19,000; and milling machines, $18,000. The value of the machine tools exported in July, 1923, showed an increase of about $135,000 over the exports in July, 1922. The total value of the exports of metal-working machinery of all kinds in July, 1923, was $1,143,000. The biggest increase was in small tools, the value of the exports of these tools in July, 1922, was less than $90,000, while in July, 1923, it was over $220,000.

The Iron and Steel Industry

Industrial activity throughout the country, every class of business considered is normal. During the first five months of the year most industries were running considerably above normal. The iron and steel industry naturally reflects this condition in that the output earlier in the year was greater than at the present time, and September orders show a material falling off; but at the same time, production is considerably in excess of pre-war standards. Production of pig iron in August was about 7 per cent less than in July, but the production of steel ingots rose nearly 5 per cent. Pig iron prices have come down considerably on account of the reduced demand, whereas steel is quoted at a comparatively high figure. It is likely that the present steel prices will not change materially during the remainder of the year, but pig iron prices show a rising tendency.

Future prospects for the iron and steel industry are good. The steel production of the world is less than it normally would have been if the world had returned to peace equilibrium. There is, in a sense, a world shortage of steel. It is estimated that if the war had not interfered with the progress of the world, at least 300,000,000 tons of steel would have been consumed in excess of what has been produced. This shortage is likely to be met whenever the world reaches economic equilibrium; in the immediate future, the Japanese disaster will create a large demand.

The United States Steel Corporation is working at slightly below 90 per cent of capacity, and the average for the whole industry is a little over 80 per cent. The demand for steel castings has fallen off considerably since early in the year, and the same is true of structural steel sales.

The Automobile Industry

Contrary to all past experience, automobile production continues extremely heavy for this time of the year, and many of the best known manufacturers are maintaining high production schedules. The Studebaker Co., for example, reports that 15,700 cars were built during August, a larger number than for any previous month. The daily production of the Ford plants has passed the 7000 mark. It is stated that the Ford business will soon embark on an extensive advertising campaign, involving an expenditure of $7,000,000 annually—a complete reversal of past policy.

The total production of automobiles during the month of August considerably exceeded 300,000 passenger cars and 30,000 trucks. The truck business has fallen off somewhat, August orders being below those for July. Dealers throughout the country, however, are reporting good prospects for fall truck business. The automobile-parts business generally is on a sounder basis than it has been for several years. Business has slackened to some extent, but the conservative policies now followed by manufacturers in this field will prevent serious results from a temporary lull in business.

Conditions in the Railroad Field

The general prosperity of the country and the normal growth of business are indicated by the record freight business handled by the railroads. For several months the railroads have handled more freight than at any previous time in their history. Fortunately, the great number of new locomotives and cars put in service during the year have enabled the railroads to handle this unprecedented freight business without difficulty, and a surplus of approximately 75,000 freight cars has been consistently maintained for several months. Over 2200 new locomotives were placed in service during the first seven months of the year, and 97,000 freight cars were added.

There are still over 1500 locomotives for domestic use on order with the various locomotive-building concerns, which should insure active business in this field for the remainder of the year. About 80,000 freight cars are still on order. The end of this year should find the railroads unusually well equipped for handling the freight of the country.

General Industrial Conditions

The index of the Federal Reserve Board indicates that while the production of basic commodities and employment in industrial establishments have decreased slightly, the distribution of goods, as indicated by railroad freight shipments, is maintained at a high level. The falling off in production is relatively small, amounting to but 1 per cent in July compared with the previous month, while employment decreased 2 per cent.

The Federal Reserve Bank's index figures indicate that production in the iron and steel field is still above normal, and the same is true of production in the automobile field. The textile industry is somewhat below normal. Business activities in general are estimated to be practically normal. It is of interest to note that with the return to normal conditions from the boom earlier in the year, there have been fewer business failures than there were during the boom period. This indicates that the business world has prepared for the slight decrease in business that has set in, and that the country as a whole is better prepared to meet future conditions than it has been for many years past. It is safe to say that progressive businesses that proceed in a cautious and conservative manner are on a firmer foundation today than they were during either the boom period or the depression that preceded the return to normalcy.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Grant Double-end Threading Machine

FOR simultaneously threading both ends of studs and rods on a quantity-production basis, the Grant Mfg. & Machine Co., N. W. Station, Bridgeport, Conn., has developed a machine that is entirely automatic in operation. The particular machine illustrated has a capacity for work up to 3/8 inch in diameter and 10 inches in length. Two opposing die-heads mounted on heads that are moved longitudinally to and fro along the bed, are employed for the threading. The work is intermittently fed from a magazine at the rear to a position in line with the die-heads, and is clamped stationary in this position by means of levers. The movement of these levers, the traverse of the heads, and the operation of the work-carrier are all effected by the use of cams. In threading 3/8-inch rods on both ends to a length of 1/2 inch, a production of 30 rods per minute is obtained.

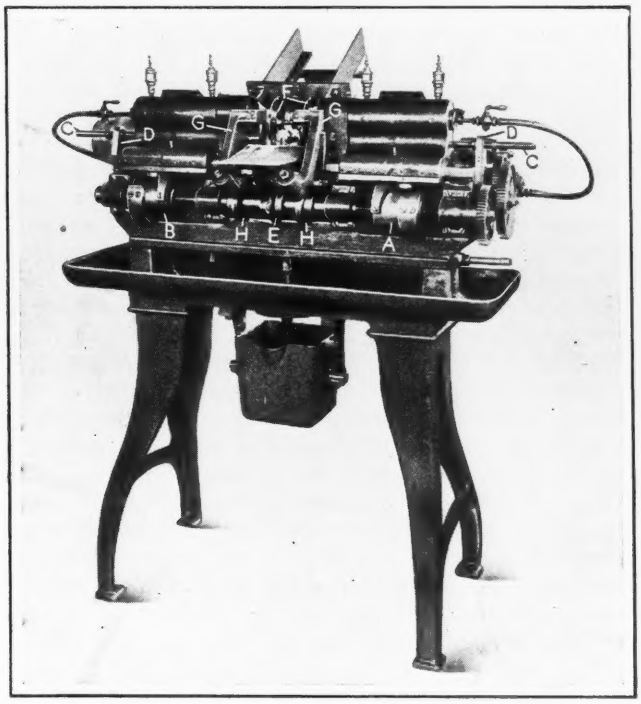


Fig. 1. Grant Double-end Threading Machine

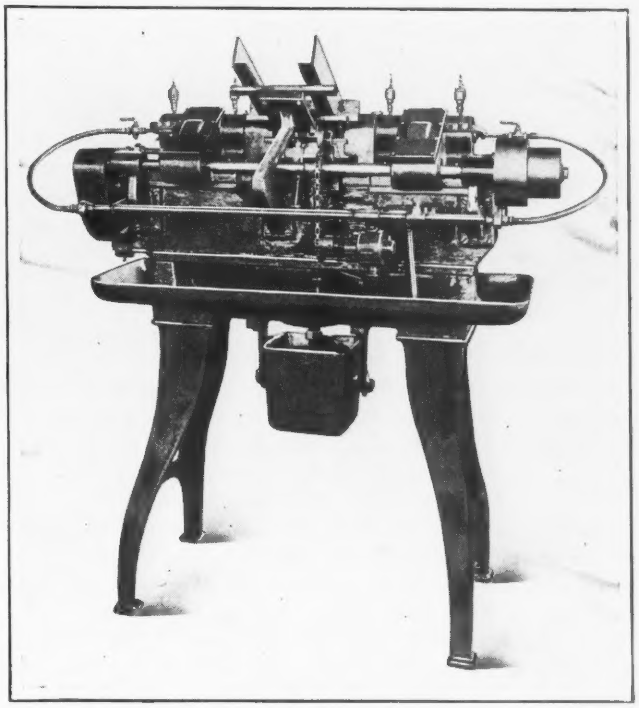


Fig. 2. Rear View of the Grant Threading Machine

Power is transmitted to the machine through a two-step cone pulley at the left-hand end of the driving shaft which runs along the entire length of the bed at the rear, as shown in Fig. 2. The spindle in each head is driven direct from this shaft by means of a train of spur gears, the right-hand spindle being driven through three gears, and the left-hand spindle through four gears. Hence right-hand threads are cut on each end of the work. The first gear in both trains slides on the driving shaft as the head traverses back and forth. The die-head spindles are hollow, and lubricant is constantly delivered through them and the die-heads to the ends of the work, the lubricant being delivered through piping and flexible tubing from a pump at the rear end of the machine which is driven by a silent chain from the driving shaft.

At the right-hand end of the driving shaft is a train of change-gears which delivers power to a camshaft extending along the front of the bed. The cylinder cams *A* and *B* carry cam-blocks that control the forward and return movements of the right- and left-hand heads, respectively, by engaging a roller on the bottom of the heads. The cam-blocks are changed to suit threads of different pitch; for instance, when 24 threads per inch are being cut, the cams must move the heads forward 1/24 inch per revolution of the die-head spindles, whereas in cutting 20 threads per inch, the heads must move 1/20 inch per revolution of the spindles. The different thread pitches can generally be provided for by simply changing the cam-blocks, but the change-gears can also be changed to obtain the proper rate of forward movement of the heads relative to the rotation of the spindles. It will be evident from this description that the die-heads are fed positively in conjunction with their rotation.

Not only is the rate of the forward and return traverse of the heads controlled by these cams but also the total length of their movements. The position of the cams on the shaft is adjustable to suit the length of work, by means of a thread and lock-nuts. Obviously, the position of the cams controls the position of the heads. Threads of different length can be cut on the ends of the work by providing cam-blocks to suit.

The die-heads are opened at the end of an operation and closed at the beginning by means of rods *C* and two adjustable stops on each rod. The rods extend through the heads and are connected to the die-heads at the front end by a fork. At the end of an operation, the forward movement of a rod with its head ends as the rear stop comes in contact with bracket *D* and causes the die-head to open. Similarly, at the end of the return movement of the head, the second stop strikes the other side of the bracket and closes the die-head.

The mechanism for delivering work from the magazine to the threading position is operated by cam *E* which actuates a roller attached to the front end of a link that extends through the machine to the rear. At the other end the link is connected to a bellcrank which, in turn, is fastened to a vertical rod that has a pawl at the upper end. The pawl engages a ratchet on a shaft that carries two disks *F*, and thus causes the shaft to rotate intermittently whenever motion is imparted to it by cam *E* through the other members of the mechanism. Each disk *F* has six notches cut into its periphery, and by means of these notches carries a piece of work from the magazine into line with the die-heads every time that the pawl rotates the ratchet.

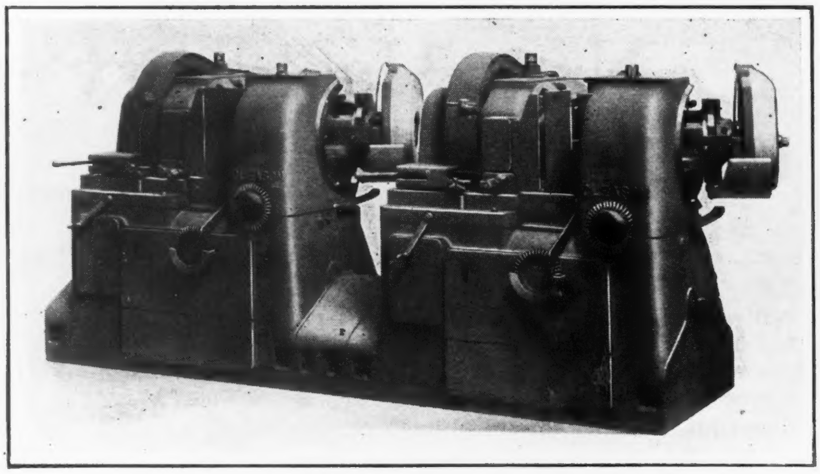


Fig. 2. Two Gleason Bevel Gear Generators set up in a Battery

As the work reaches the threading position, levers *G* are rocked forward by the movement imparted by cams *H*, clamping the work firmly against two hardened pads and holding it there until the threading is completed. Then, as the rollers ride on the low part of cams *H*, the levers swing forward again and release the work, which is now permitted to roll forward across the sheet metal into a receptacle. Hardened V-blocks are fastened to levers *G* to contact with the work. The rollers of these levers are backed up by coil springs which, in the event that work is clamped improperly for an operation or large work is fed by error, allows the rollers sufficient movement to eliminate the danger of breaking a part. The rocking levers pivot on bearings at the center of the bed.

GLEASON BEVEL GEAR GENERATOR

A single-purpose machine designed for producing bevel gears on a mass production basis is now being placed on the market by the Gleason Works, Rochester, N. Y. From Fig. 1 it will be seen that in appearance the machine is a radical departure from the bevel gear generators of the universal type built by this concern. However, the same basic principle of generating the tooth is used, the tooth contour being developed by rolling the work and the tools together at a uniform pitch-line velocity. The tools represent the adjacent teeth of a crown gear, and as they reciprocate, they cut away the stock on the work and in this way develop the tooth profiles.

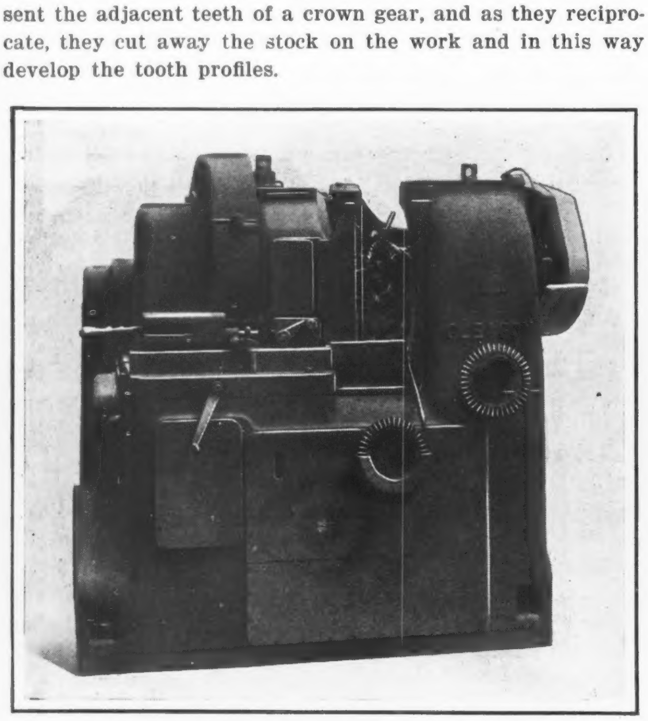


Fig. 1. Gleason Single-purpose Straight Bevel Gear Generator

The generating motion is obtained by means of a crown gear and segment, the generating roll being entirely on the work-holding member. This arrangement has been developed into a simple and rigid design which makes very accurate work possible, owing to the few parts and fits involved. The indexing mechanism is of the notched-plate type and is operated by the generating roll. The index-plates are hardened and ground. The tool-carrying unit is mounted on an upright, which, instead of swinging about a center, is given a lateral movement by a cam to feed the tools to the work. This permits the whole unit to be gibbed with simple adjustments for taking up wear. The relief movement for the tools during the return stroke is operated mechanically and is positive in action. The clapper-box is integral with the slide.

Only a slight movement is necessary for the relief of the tools, as the swivel pins on which the clapper-blocks swing are behind the cutting edges of the tools and almost in line with their travel. Because of this small movement, the machine is unusually quiet and steady in operation, and as the drive for the tools is arranged to have the effect of a draw cut, high tool speeds can be maintained practically without vibration or noise and the work produced has a very smooth finish. The tool-carrying slides are arranged to over-run the arms at both ends so that a long run of work on any job will not wear a depression in the bearing surfaces of either part. One large gib is provided on each slide to take up wear in all directions. The tools are the same as those used on the 11- and 18-inch Gleason generators.

Every point on the machine requiring oiling is flood lubricated by means of a single pump circulating system. There are two places for inspecting the flow of oil, which are always within sight of the operator. In addition to all rotating bearings, the tool-slides and all hand adjustments are reached by this central oiling system, and even such points as the notches in the index-plates and the surfaces of ratchet pawls are oiled by it. Chips are removed and both lubricating oil and cutting compound replenished without stopping the machine. The chips drop into a basket that swivels on trunnions and when full tips over so that the chips fall into a second basket at a lower level and remain there until removed.

The machine is started by means of a lever which affords a sensitive control, so that it is possible, if necessary, to "inch" the tools very small distances. The main driving pulley has a heavy rim, and on account of running continuously, is in effect a flywheel. Power is transmitted to the main shaft of the machine through a disk friction clutch. In operation, when the machine reaches the reloading position, an automatic stop disengages the friction clutch to stop the machine. When the automatic stop releases the clutch, the pulley runs free, and as there is but slight momentum in the machine, it stops without appreciable "coast-

ing." In starting, there is no time lost because the momentum of the constantly revolving pulley brings the machine up to full speed as soon as the clutch is engaged.

The work-head is especially designed for differential gears and pinions, and can be arranged to handle work having a pitch angle between 61 and 29 degrees. Each gear or pinion requires a crown gear and segment corresponding to its pitch angle and an index-plate for the correct number of teeth. For greater and less pitch angles than mentioned, a separate work-head is needed. The machine can be arranged to cut gears within the following specifications: Greatest cone distance, 4½ inches; least cone distance, 2 inches; greatest pitch angle, 75 degrees 58 minutes; least pitch angle, 14 degrees 2 minutes; extreme ratio for right-angle bevel gears, 4 to 1; largest gear of 4 to 1 ratio, 8¾ inches; largest gear of 2 to 1 ratio, 8 inches; largest gear of 1 to 1 ratio, 6¾ inches; largest diametral pitch, 4; longest face, 1¼ inches. One cutter speed is supplied in the range of 300 to 500 strokes per minute. The time for generating one tooth ranges from four to thirty seconds.

Two of these machines set up in a battery are shown in Fig. 2. The surfaces where the machines come together are planed parallel so that the joints are true and tight. The machines in both illustrations are arranged for a motor drive, the motor being located on the back of the machines and connected by belt to the main driving pulleys. A three-horsepower motor supplies ample power for driving each machine. Repair work or replacement of parts on machines set up in a battery may be accomplished without moving any of the machines.

GRAY TWIN-RAIL LONG-REACH PLANER

A maximum-service planer with twin rails, intended for work requiring a longer reach than is available on the regular planer, combined with heavy cutting, has been brought out by the G. A. Gray Co., Gest & Depot Sts., Cincinnati, Ohio. The size of the machine is 60 inches by 44 inches by 16 feet, and it was designed primarily for planing the inclined sides of steel safe doors that are sometimes as much as 30 inches thick. Heavy wide forming cuts without chatter 30 inches below the bottom of the rail, are necessary in this work.

As will be noted from the illustrations, the rail is built up of two members which are securely bolted together and move as one unit. The saddles have a solid bearing against

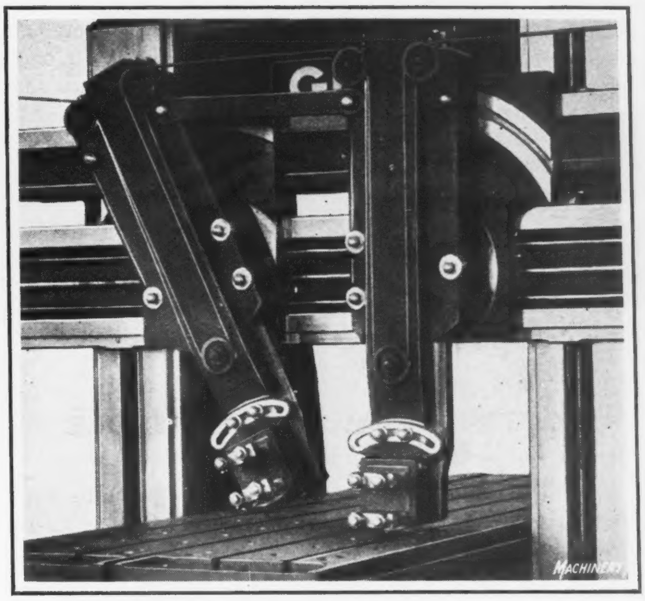


Fig. 2. View showing the Method of swiveling a Head quickly

the bottom of the lower member, an adjustable gibbed bearing on its top surface, and a supplementary bearing against its rear face. In addition, the saddles also have an adjustable gibbed bearing against the rear of the upper member. The top and bottom bearings are thus localized on the lower member to obtain the advantages of a narrow guide, while the bearing against the rear of the upper member provides the required stiffness.

Most of the weight of the heads comes on the upper rail member, and for this reason three ball-bearing rollers are provided in the top of each saddle. This construction obviates wear or deflection of the lower member, so that it remains true and insures that the head always moves parallel to the table top. At the same time the effort of moving the head is so reduced that the operator can easily set it by means of the ordinary crank from the end of the rail. The ram-carriers can be swiveled on the saddles, and are bolted to the lower portion of the saddles and also to a supplementary support near the top. The rams have a rapid traverse, as well as hand and power feeds, and because the carriers can be swiveled, the rams have an automatic feed in any direction.

A simple method, for which a patent has been applied, is employed to swivel the heads quickly. As shown in Fig. 2, a bar is slipped over collars provided on the heads, after which the ram-carrier of the head to be swiveled is loosened, and the opposite head is moved by the power traverse to cause the loosened ram-carrier to swivel. In Fig. 2, the left-hand ram-carrier is shown being swiveled by the right-hand head. After having obtained an approximate setting with the power traverse, the operator can get an accurate setting by moving the right-hand head with the crank. He can then clamp the left-hand ram-carrier, loosen the right-hand one, and swivel that to the desired angle by using the left-hand head in the manner just described. Twin-purpose taper gibs insure rigidity to the heads while cutting, one of these gibs being provided between the ram and the ram-carrier. Turning a handle in one direction adjusts the gib to the operating position, while turning it in the other direction locks the ram to the carrier throughout its entire length. A similar gib is furnished between the saddle and the rail.

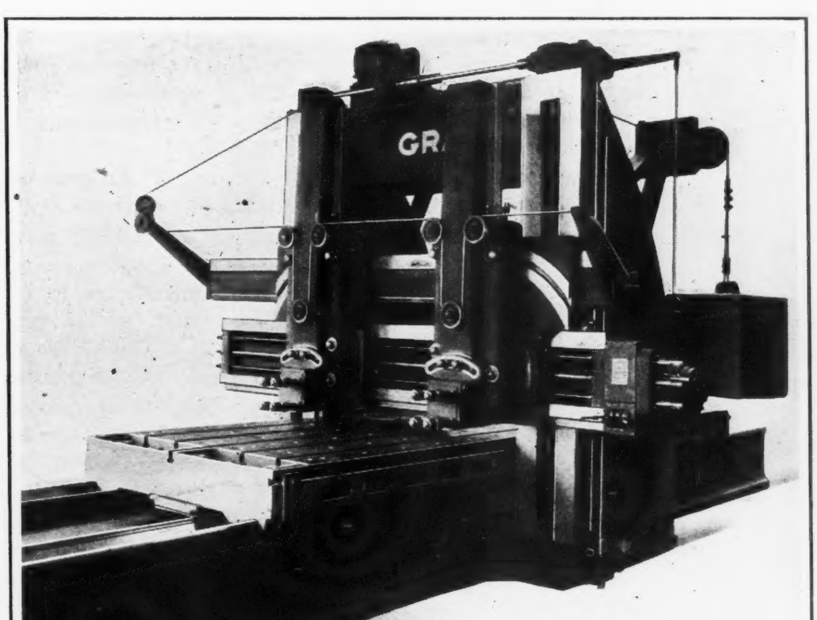


Fig. 1. Gray Maximum-service Planer with Twin Rails intended for Work requiring a Long Reach

The new planer is also equipped with the Gray "Cantslip" feed, balanced helical driving system running in oil, and single-shift rapid traverse. Both the lower and upper members of the rail are clamped to the inside of the housings by independent locks. The rams and rail are independently counterbalanced. The table is provided with steel hold-down gibs running its entire length, and these are automatically oiled from a forced system which lubricates the vees. The bed is of double length, so that the table never overhangs. Some idea of the proportions of the planer can be gained from the fact that the bed weighs 14 tons; the table and rack, 10 tons; the housings, 6 tons; the rail, 6 tons; and the top brace, 1 ton.

FOOTE-BURT MULTIPLE-SPINDLE BORING MACHINE

A multiple-spindle machine for boring and reaming automotive cylinders and for other miscellaneous boring operations on a range of work has been developed by the Foote-Burt Co., Cleveland, Ohio. This machine, which is illustrated in Fig. 1, represents a considerable improvement over previous machines built by this company for handling the same classes of work. It is intended for use on production jobs where such parts as cylinders and sleeves are to be machined in quantities, and for this reason the spindles are set at fixed center distances and the speed and feed are usually supplied to suit the particular job to be handled.

In order to provide for performing two or more boring operations on the same machine, the head is made detachable and bolted to the rail, which is provided with T-slots. To change this detachable head, it is merely necessary to loosen the bolts and dowel-pins and disengage the couplings that connect the head with the main driving shaft at one side of the machine and with the feed mechanism at the opposite side. Then the head to be used on another boring job may be placed on the

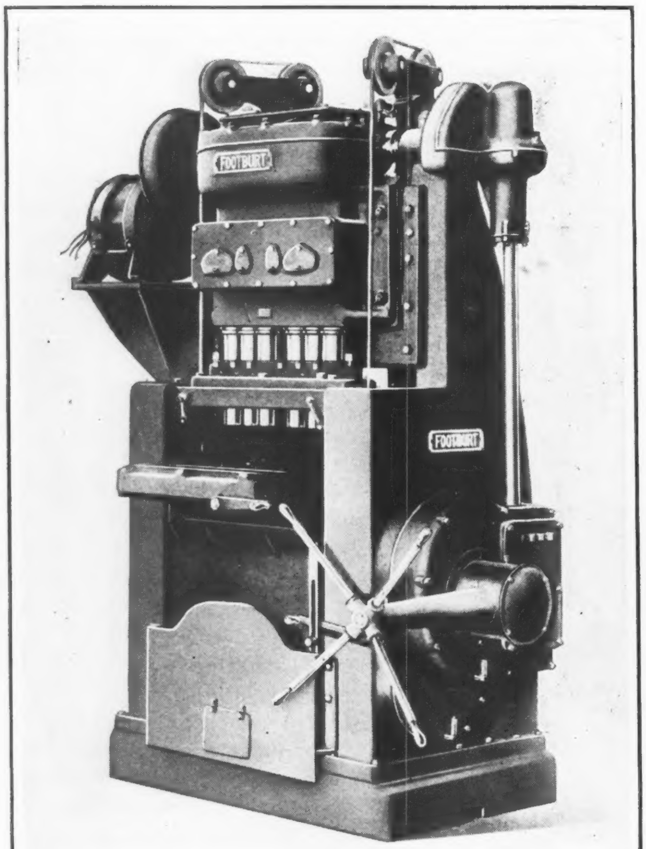


Fig. 1. Foote-Burt Multiple-spindle Boring Machine

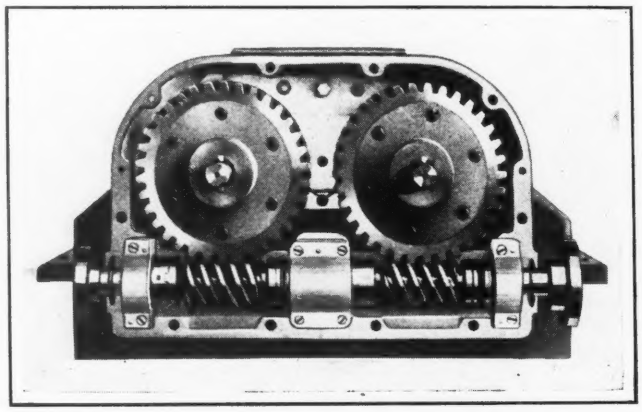


Fig. 2. Drive to the Spindles of the Boring Machine

machine and the driving mechanisms coupled up again. The jig plate which holds the bushings for guiding the spindles is easily interchanged with the head. This interchangeability of heads and jig plates provides for using the same machine on different boring jobs which may come up from time to time.

The machine can be arranged with either a belt or motor drive. On the machine illustrated a motor is mounted on a bracket secured to the column. Adjustments of speed to compensate for variations in the hardness of castings, etc., are obtained by regulating the speed of the variable-speed motor on motor-driven machines, and by shifting the belt on the cone pulley of belt-driven machines. Power is transmitted from the motor through reduction gears to a main driving shaft in the head on which there are two worms, as illustrated in Fig. 2, which transmit motion to the two worm-wheels.

On the six-spindle machine each of these worm-wheels is mounted at the top of the middle one of a group of three spindles and under the worm-wheel is a spur gear which transmits power to spur gears mounted at the tops of the other two spindles in the same group. These spur gears have their faces divided into two sections, the teeth of one section being of a coarse pitch to carry the load, and those of the other section of a finer pitch to divide up the points of contact and insure a smooth drive. The drive to the spindles of machines equipped with a different number of spindles is somewhat similar.

The main driving shaft, which carries the two worms, is mounted in roller bearings and is equipped with ball thrust bearings to take the end thrust of the worms. Each spindle rotates in adjustable tapered bronze bearings, and its endwise load is taken by ball thrust bearings. The spindle head is lubricated by means of a force-feed system in which the lubricant is delivered by a geared pump located at the rear of the head cross-rail.

The head occupies a fixed position on the machine and the feed is accomplished by raising the work-table. Four feeds are provided through two sets of pick-off gears mounted in the gear-case at the top of the machine on the right-hand side, in which all the mechanism runs in oil. Power is taken from the main driving shaft in the head and carried through spur and bevel gears to the vertical shaft on the right-hand side of the machine. From this shaft power is delivered through worm and spur gearing to pinions that mesh with racks on each side of the table to raise and lower the work to and from the tools in the spindles. The feed is engaged by meshing a knock-out worm with a worm-wheel, and it is disengaged by withdrawing the worm from the wheel.

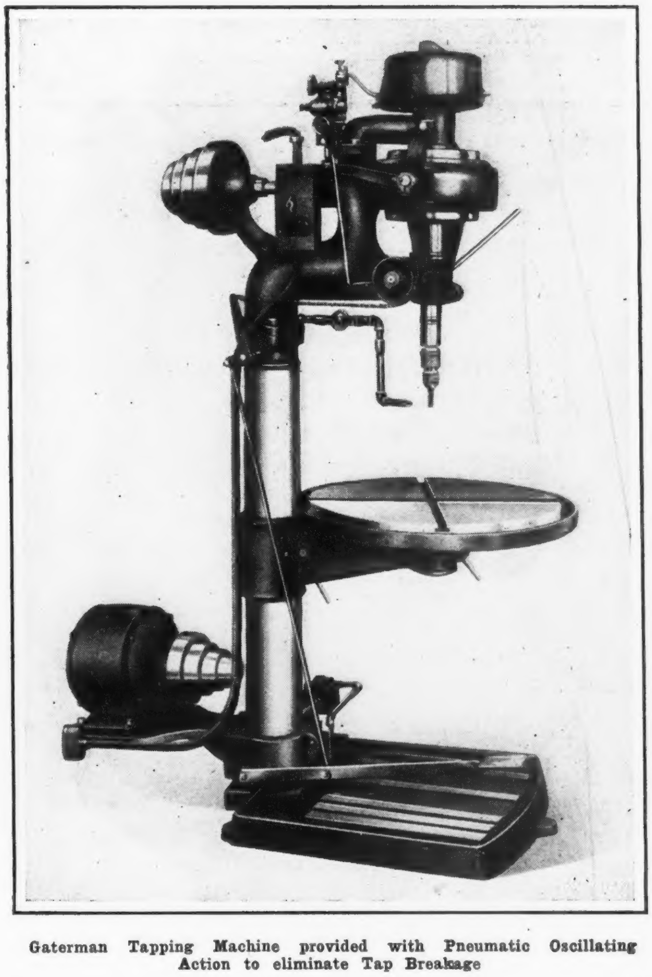
Secured to the work-table is a slotted bar on which a feed-trip may be set in any desired position. When the table is fed upward to the end of its stroke, this trip engages a bellcrank lever, and by rocking this lever, causes a latch to release a hand-lever that controls the engage-

ment of the knock-out worm. Then a spring throws the worm out of engagement with the worm-wheel to stop the feed. The capstan wheel provides for adjusting the position of the table by hand. The table is counterweighted, steel cables connecting it with the counterweights which slide in cylindrical guards at the back of the machine. All parts of the mechanism are thoroughly guarded to protect the operator and prevent dirt from damaging gears and bearings.

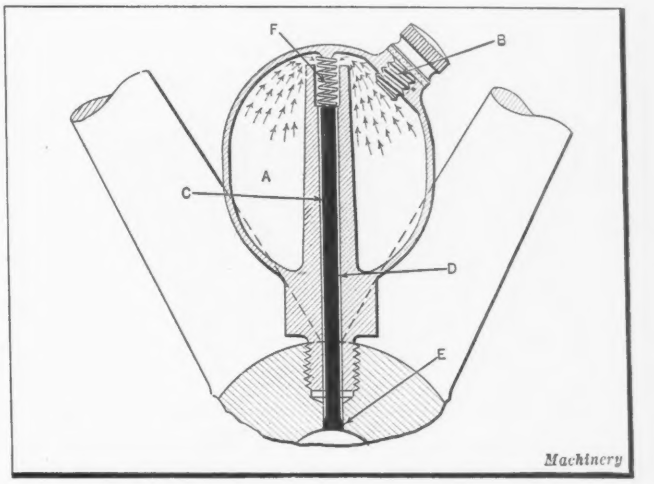
GATERMAN PNEUMATIC OSCILLATING TAPPING MACHINE

An improved automatic tapping machine equipped with a pneumatic oscillating arrangement to eliminate tap breakage is now built by the W. Gaterman Mfg. Co., Franklin and 15th Sts., Manitowoc, Wis. The pneumatic device automatically oscillates the tap spindle when the strain on the tap is greater than is advisable, and thus reduces the strain. In previous designs, an electromagnetic device was employed to oscillate the spindle, but the pneumatic arrangement has been substituted because it delivers more pressure on the clutches and thus gives the machine greater capacity. It is also more advantageous for automatically chucking parts to be tapped, and takes the place of all the different electromagnetic controls formerly required for various electric currents.

The load on the tap is carried by a cushion coil spring that deadens all shocks not only on the tap but also on the entire machine. The strain on the tap is said to be weighed to a fraction of an ounce, and the desired strain is obtained by adjusting a knurled nut. The machine is built in two sizes, the No. 4 having a capacity for tapping holes from 1/8 to 5/16 inch in steel, and the No. 8 from 1/4 to 3/4 inch. The No. 4 machine weighs about 375 pounds, and the No. 8 (shown in the illustration) weighs about 850 pounds.



Gaterman Tapping Machine provided with Pneumatic Oscillating Action to eliminate Tap Breakage



Advance Oiler for Loose Pulleys and Clutches

ADVANCE LOOSE-PULLEY OILER

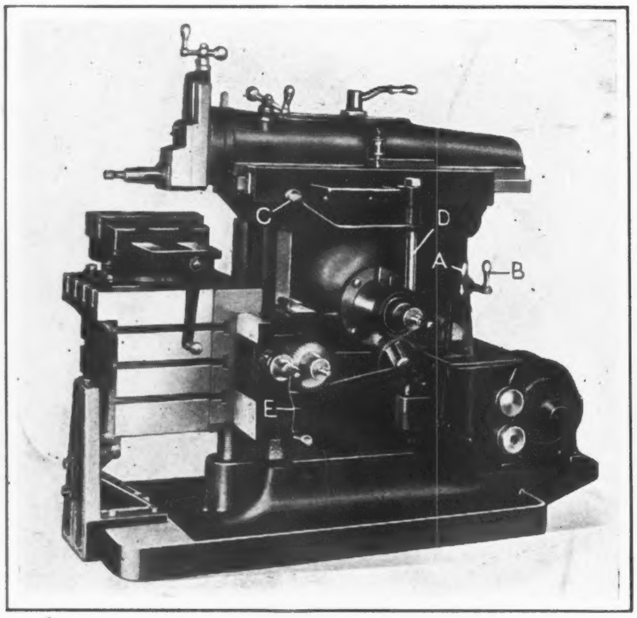
An oiler that applies the principle of centrifugal force for lubricating loose-pulley bearings has been brought out by the Advance Specialty Co., 524 Butterworth St., S. W., Grand Rapids, Mich. The accompanying illustration shows a sectional view of this device. Oil is contained in reservoir *A* in which it is replenished as required through the tapped hole that is fitted with threaded plug *B*. As the pulley or clutch carrying the oiler revolves, centrifugal force throws the oil to the top of reservoir *A* and thence through channel *C* which leads to the bearing *E*. Therefore, oil is forced to the bearing all the time that the pulley is in motion.

Channel *C* is almost filled by pin *D*, which leaves just sufficient space for delivering enough oil to lubricate the bearing efficiently. Pin *D* is of such length that it just contacts with the shaft and is held against it by coil spring *F*. When the pulley or clutch stops rotating, a partial vacuum is caused in reservoir *A*, and as centrifugal force is no longer effective, this vacuum withdraws the oil in channel *C* to reservoir *A*. It is claimed that this device feeds an even, continual film of oil on the bearing surfaces that is automatically regulated. The device is made in two sizes, the No. 1 size being intended for pulleys from 5 to 10 inches in diameter, and the No. 3 for pulleys 10 inches and larger in diameter.

AVERBECK SHAPERS

A line of Averbeck single-pulley-driven shapers is now being manufactured by the Steel Products Engineering Co., Springfield, Ohio, in 20-, 24-, 28-, and 32-inch sizes. The controls for all ram and knee movements are centralized at the front of the machine where the operator can reach them without shifting his position. There is a gear-box furnished that affords four speed changes, which, with the back-gears, gives a total of eight changes ranging, on the 20- and 24-inch machines, from 9 to 103 ram strokes per minute, and on the 28- and 32-inch shapers, from 6 to 90 ram strokes per minute.

The speed-box is of the selective sliding-gear type, the four changes being secured through lever *A*. Lever *B* is moved to operate the back-gears so as to double the number of speed changes, as previously mentioned. Lever *C* controls the clutch on the single pulley. This lever and vertical rod *D* are the only members of the clutch-shifting mechanism located outside the frame of the machine. The remaining members are enclosed so that they are out of the operator's way and protected from dirt. The clutch has a brake which is engaged as the clutch is thrown out, thus saving time by quickly stopping the travel of the ram. An individual motor drive can be furnished for the shapers, in which case power



Averbeck Single-pulley driven Shaper

is transmitted from the motor to the machine through a silent chain. Lever *E* is duplicated on each side of the machine for adjusting the position of the knee. On 28- and 32-inch machines the bull gear and pinion have helical teeth.

In these new shapers, the balanced ram mechanism supplied on the cone-driven shapers built by this company, has also been incorporated as one of the features of design. This mechanism absorbs vibration, prevents jerk in reversing the ram at high speeds, eliminates chatter, and enables the ram to be advanced at a constant speed and returned in the same manner. The rocker-arm driving block is provided with adjustment to eliminate play or slap in the rocker-arm slide and thus insure a smooth motion.

FEDERAL TUBE AND PIPE WELDER

In producing gasoline by the Cracklin process under certain patents, a temperature of 1000 degrees F. and a pressure of 500 pounds per square inch are called for, and pipe coils of the type shown in Fig. 2 are used. To weld such coils so that they would withstand the severe conditions imposed, the Federal Machine & Welder Co., Dana Ave., Warren, Ohio, designed the No. 90 butt welder illustrated in Fig. 1. The coil is formed of 4-inch extra-heavy drawn

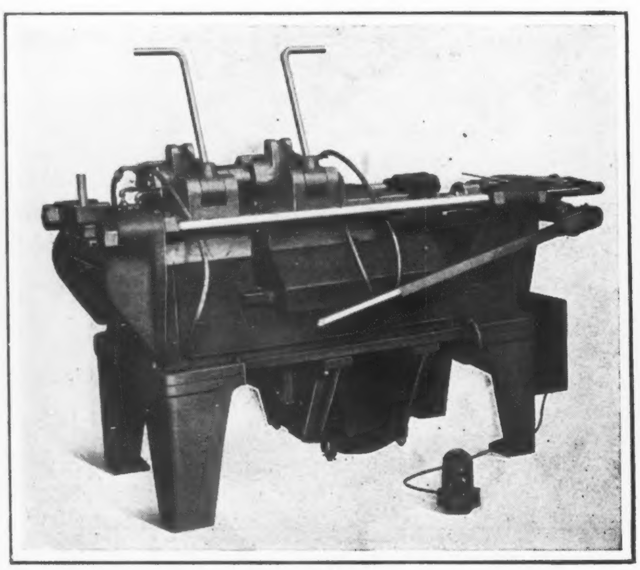


Fig. 1. Federal Butt Welder for Tubes and Pipes

steel tubing having a cross-sectional area of 4½ square inches. There are eight welds per coil, and when completed it measures 9 feet in width by 13½ feet in length and weighs about 1800 pounds. We are informed that from forty to sixty minutes was formerly required to make one weld with an arc welder, but that with this butt welder one operator and a helper complete a coil of eight welds in fifty minutes, including the time necessary to shift the coil from weld to weld. Each coil is tested by being subjected to a pressure of 2000 pounds per square inch after completion. The machine has a capacity for 7 square inches of stock, which would include 3-inch round solid stock or 4½-inch tubing.

The transformer is of a special design, and the primary coils are wound of copper ribbon, insulated with mica between the layers and covered with asbestos tape. The secondaries are of special composition copper, constructed with water passages through the castings to permit the circulation of water during the welding operation. The purpose of this construction is to eliminate excessive rises in temperature under overloads and continuous hard service. The electrical construction is such that the machine will operate

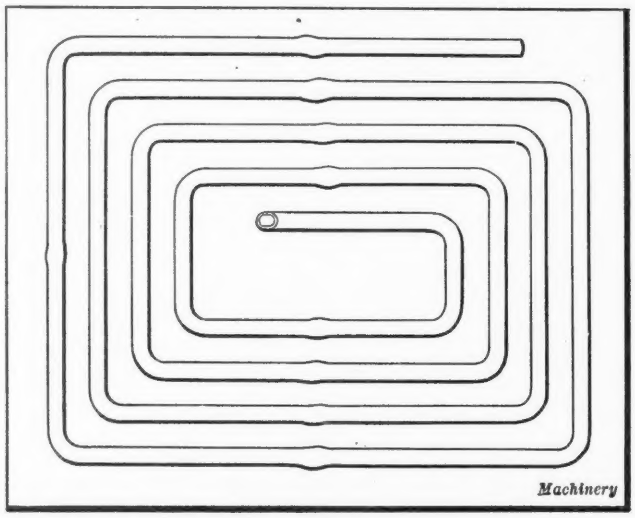


Fig. 2. Diagram of Still Coil welded by Machine shown in Fig. 1

continuously at the rated capacity without undue heat. In an efficiency test two pieces of steel 6 inches wide by 1 inch thick were welded in thirty seconds at a current consumption of 120 kilovolt-amperes or 60 kilowatts.

THOMSON SPOT-WELDER

The model 100 spot-welder now being placed on the market by the Thomson Spot Welder Co., Lynn, Mass., has a capacity up to 20 kilowatts and covers the welding range formerly covered by the 5-, 10- and 15-kilowatt welders manufactured by this concern. The machine may be equipped with water-cooled horns and solid copper die points, or with water-cooled horns and water-cooled die shanks having solid copper die inserts.

Among the improved features is a new design of primary coil, which is said to be practically fireproof even though the machine is considerably overloaded. The transformer is of the "split-core" type, which makes it possible to remove primary coils quickly without dismantling the transformer. This construction is of value in case it is desired to change the voltage of a power line or for other reasons to instal new coils. The welding current is carried by a patented secondary lead and terminal connection. It is said to give a more uniform distribution of the current through the various strips of copper that make up the lead, and so permits the lead to carry more current without

overheating. The improved connection permits a direct contact between each strip of the lead and the terminal. The contact is seven times the cross-sectional area of the strip, thus eliminating any tendency to heat at this point.

A new pressure spring with adjusting features has been designed to make the operation of the machine easier and to insure longer life of the spring. When the machine is properly adjusted the operator cannot apply the current until pressure has been applied to the electrodes. When the material reaches the proper welding heat, the current is automatically cut off by applying further pressure on the foot-pedal. The switch may be operated through either a selected spring pressure or a rigid pressure. After pressure and spring adjustments have been made, it is only necessary for the operator to push the foot-pedal through the full movement at a uniform speed. The treadle is of machine steel, and may be bent to suit the operator.

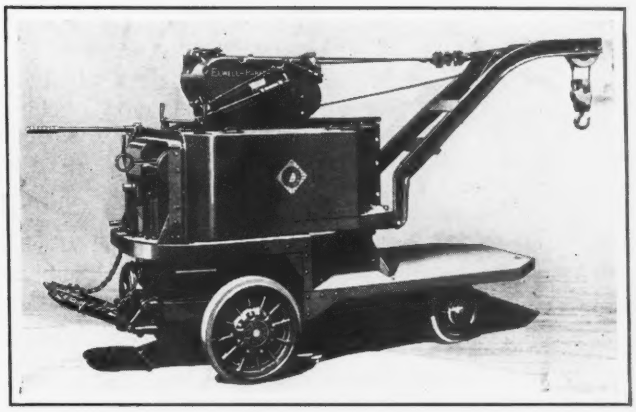
Part of the standard equipment supplied with this machine is a double-pole magnetic contact switch, which is

Thomson Model 100 Spot-welder

mounted on the wall, entirely separate from the welder, in accordance with regulations approved by the Underwriters' Laboratories. This switch opens and closes the primary circuit on both sides of the power line, with the result that when the switch is open, the welder is cut off entirely from the circuit. This enables the operator to make adjustments or repairs without receiving a shock. The maximum welding capacity of the machine is 2 pieces of steel or iron, each 5/32 inch thick, 2 pieces of brass, each 1/16 inch thick, or 2 pieces of aluminum, each 1/16 inch thick. It is 50 inches high and occupies a floor space of 48 by 20 inches. The weight is approximately 1000 pounds.

ELWELL-PARKER CRANE TRUCK

An electric truck which is equipped with a crane and is designed especially to meet the needs of a railroad general storekeeper has been brought out by the Elwell-Parker Electric Co., Cleveland, Ohio. This type CL truck is of the same general design as one described in July, 1922, MACHINERY, except that the crane on the new truck has a shorter boom. The hoist mechanism consists of a motor which drives two separate drums through worm-gearing running in oil. Each drum is fitted with a 3-inch plow-

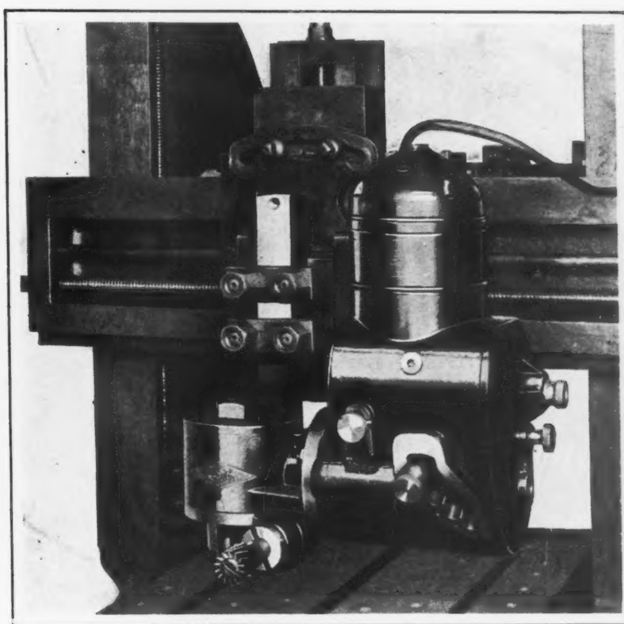


Elwell-Parker Electric Truck

steel cable, one being employed to raise and lower the boom and the other to control the hook. The drums are operated independently of each other so that the load may be picked up at any point over an end or side of the truck. The motor for driving the truck is direct-connected through worm-gearing to the axle beneath the battery, just back of the crane column. This motor and the hoist motor receive power from the same battery. A separate controller is used to operate each motor. The wheels are equipped with solid rubber tires, and all four wheels may be steered.

UNIVERSAL MILLING DEVICE FOR PLANERS

A milling attachment which is designed primarily for use on planers, but is also adaptable to other machine tools, is manufactured by the Up-To-Date Tool Co., 81 Wareham St., Boston, Mass. The accompanying illustration shows the attachment applied to a planer. It accommodates circular milling cutters from 5/8 inch to 5 inches in diameter, and any size end-mill, drill, or drill chuck. The spindle is regularly provided with a No. 9 B. & S. taper socket, but it can be made with a No. 3 Morse taper socket. The application of this attachment to a planer makes it possible to perform drilling and milling operations on a piece of work while it is on the planer, and thus eliminates other set-ups for these operations. It may be used to produce cross-cuts, such as tongue slots at right angles in milling fixtures; to mill small surfaces for joints, locating grooves, or T-slots; and to drill or bore holes, etc.



Universal Milling Device made by the Up-to-Date Tool Co.

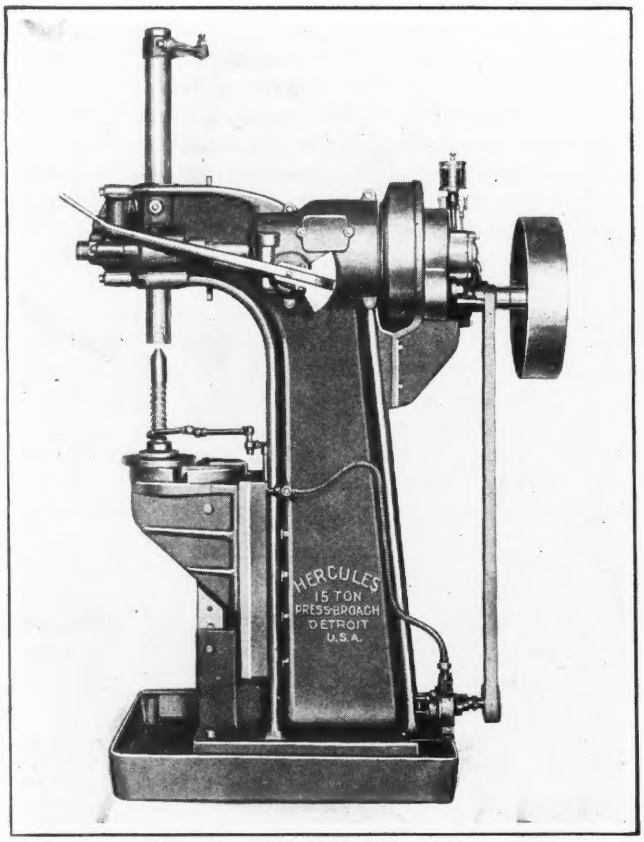
There is a direct motor drive through a change-speed gear-box by means of which eight spindle speeds are obtainable in both a left- and right-hand direction, ranging from 44 to 209 revolutions per minute. Any angular position of the cutter is possible by setting two graduated flanges to suit. This provision makes the device universal in its application. The motor is of 1/2 horsepower capacity, and is selected for the voltage and current with which it is to be used. The cutter-spindle is hardened and ground, and has a driving slot in the end for use when milling cutters are mounted on an arbor. This device weighs approximately 140 pounds.

GEIST ROLLER PIPE CUTTER

A No. 2 heavy-duty roller pipe cutter for pipe from 1/8 inch to 2 inches, inclusive, has been brought out by the Geist Mfg. Co., Waynesboro, Pa. The cutter is made from tool steel; it is heat-treated to give it maximum wearing qualities and can be reground when dull. The cutter-shaft bearing is provided with an adjustable cap on the cutter side for taking up any wear that may occur. This feature of the design is said to add materially to the life of the machine.

The rollers are made from tempered tool steel and are carried in roller bearings. The cage that supports the rollers is elevated to the cutter by means of a cam that is operated jointly by a pedal and lever. The pedal and lever can be positioned to suit the operator and their movement limited by an adjustable stop. The sliding surfaces of the cage are protected from scale and dirt by a flexible guard. The rollers are adjustable to suit different sizes of pipe by means of a handwheel located beneath the rollers. A small cage of rollers for accommodating pipe from 1/8 to 3/8 inch in size can be attached to the large cage without removing the regular rollers.

A length gage that is adjustable for different lengths of pipe up to and including four feet is provided. All parts coming in contact with the revolving pipe are hardened to resist wear and all spindles and shafts are ground and run in bronze-bushed bearings. The gears are enclosed, but are readily accessible at all times. This machine is sold by the Landis Machine Co., Waynesboro, Pa.

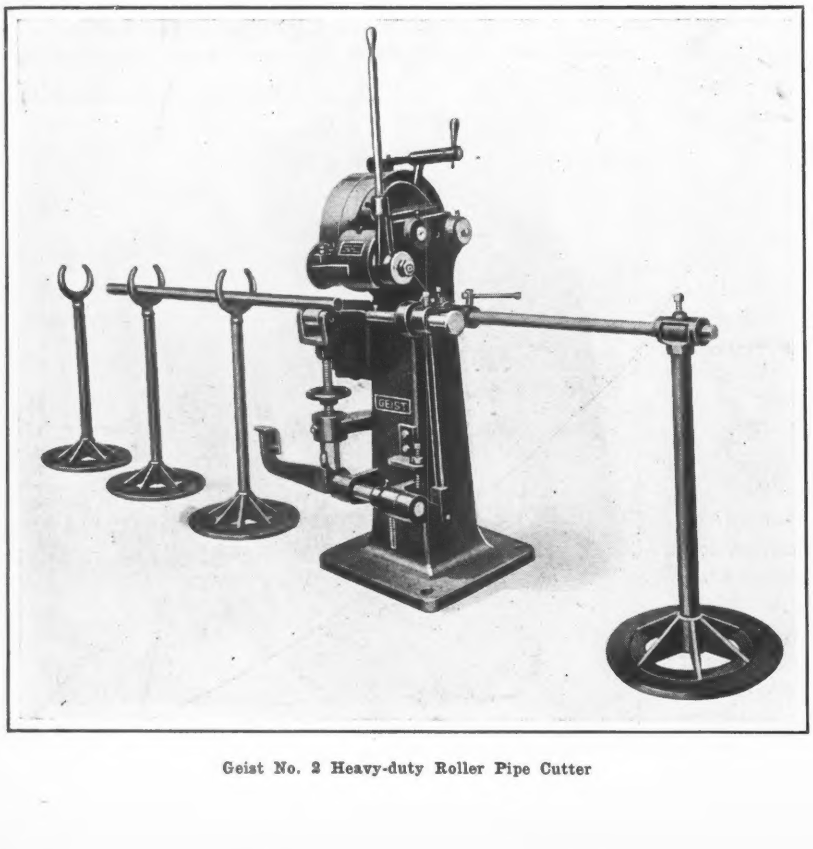


Hercules Combination Broaching Machine and Power Press

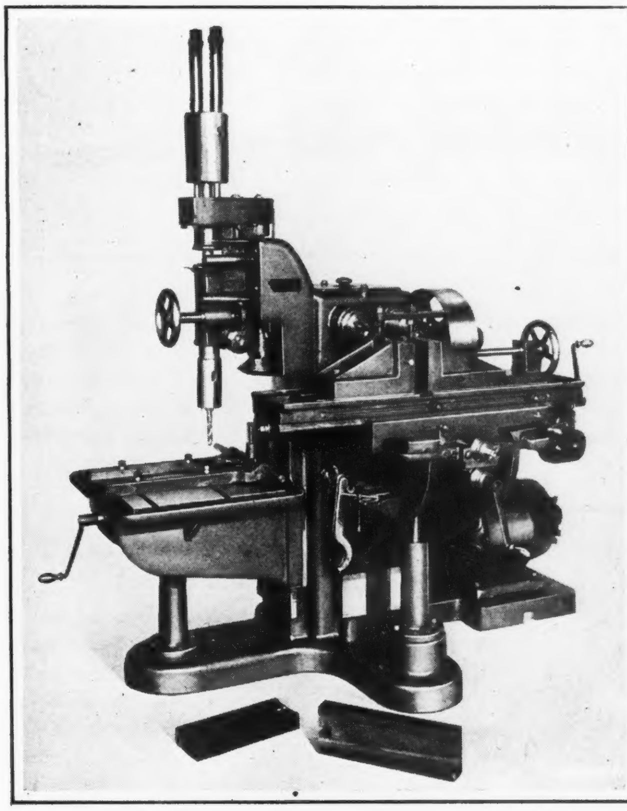
HERCULES BROACHING MACHINE AND POWER PRESS

A vertical combination broaching machine and power press is being built by the Hercules Mfg. Co., 446 Woodbridge St., E., Detroit, Mich. The machine is rated at 15 tons capacity, is equipped with a 36- by 3-inch ram that has a 24-inch travel, and occupies 4 1/2 by 2 1/2 feet of floor space. The knee is removable to allow the use of special fixtures, and the machine is equipped with a trip arm that can be set to stop the ram automatically at any predetermined position. Pressure is delivered to the ram through a train of steel gears and a double friction clutch by means of which any pressure from zero to maximum may be obtained for driving bushings and similar parts down to a shoulder. The fast speed of the ram up and down is 50 feet per minute, and the pressure feed down for heavy-duty work is 84 inches per minute. All speeds are controlled by means of one lever.

Owing to the fact that the work is held vertically for broaching, the lubricant can readily flow through it during the operation. The broaches are pushed through the work by adapters held in the ram, and thus require only short shanks. They are made with 60-degree ends to which the adapters are fitted. Some of the advantages claimed for broaching on this machine are greater production because of the fast speeds; heavier cuts and smoother work owing to gravity lubrication; less tool breakage on account of the alignment and method of using the broaches; and saving in initial costs by the use of short broaches. The machine is a self-contained unit provided with a lubricant reservoir in the base and a pump and pipe connections. It can be furnished with belt or motor drive.



Geist No. 2 Heavy-duty Roller Pipe Cutter



Harrington Combination Drilling and Milling Machine for producing T-slots in Locomotive Wedge Blocks

HARRINGTON LOCOMOTIVE WEDGE-BLOCK MILLING MACHINE

For the rapid production of T-slots in locomotive driving-box adjusting wedges, the Harrington Co., 17th and Callowhill Sts., Philadelphia, Pa., has brought out the combination milling and drilling machine here illustrated. One side of this machine is equipped with a drill spindle, while another side is provided with two parallel milling spindles that run at different speeds. Two holes are drilled at a close center distance in each wedge block, in order to remove most of the metal prior to the T-slot milling operation. Both hand and power feeds are furnished for the drill spindle, and there is an automatic trip. Adjustable guides and variable stops are provided for the vertically adjustable table under the drill spindle to facilitate rapid drilling. The two strips on the table are also adjustable sidewise to suit the width of the various wedge blocks. The block to be drilled is placed between the guide strips and pushed back against an end stop, which is adjustable so as to locate the work properly for drilling the first hole. After this hole has been drilled, the stop is raised and the wedge block is pushed against a second stop for drilling the second hole.

The milling spindles are driven through spiral gearing flooded by a bath of oil. There is a vertical adjustment for the milling table, and it carries a compound table. The latter has an in-and-out movement parallel to the axes of the milling spindles and a transverse movement at right angles to the spindles. There is a power feed for the transverse movement, and an automatic trip is furnished for stopping the feed at any predetermined depth. A specially designed vise mounted on the table holds the wedge blocks with the narrow edge uppermost. The sliding jaw is clamped quickly by means of a handwheel and screw, and a clamp over the top of the jaws can be used to prevent the work from rising.

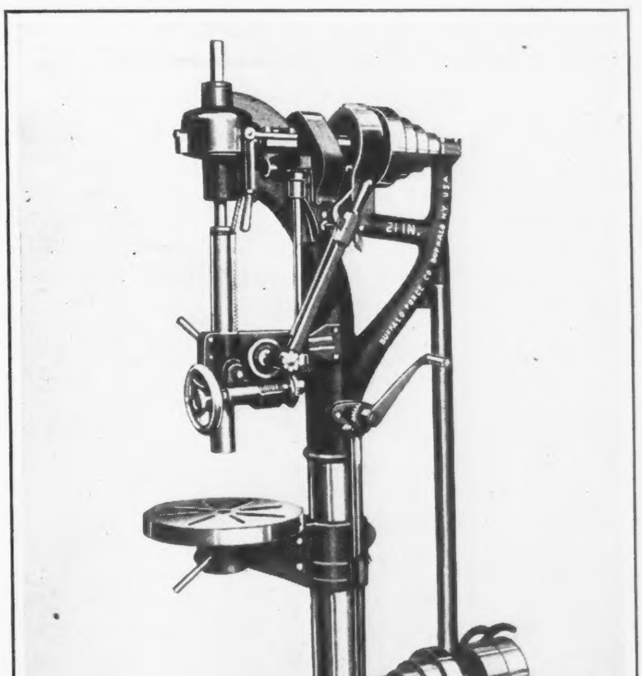
The left-hand spindle rotates rapidly and drives a straight end-mill, while the right-hand spindle rotates slowly and drives a T-slot cutter. The two different spindle speeds result in about the same cutter surface speed. The table is fed from left to right, the end-mill first removing the metal left after the drilling operation and the T-slot then being cut as the work is fed toward the right-hand spindle. There is a base extension for the motor, which is belt-connected to the machine and should preferably be of the adjustable-speed type so as to permit a range of spindle speeds for cutting different materials. Four feeds can be obtained by means of constant-center change-gears.

BUFFALO UPRIGHT DRILLING MACHINE

In a new 21-inch geared upright drilling machine built by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y., the principal departures from older types manufactured by this company are the use of a positive gear feed instead of a belt-driven feed, and the placing of a brace between the lower pulley shaft and the upper part of the frame. The design of the new model is such that the machine can also be furnished without the brace if desired. There are eight spindle speeds obtained through the use of back-gears, as well as three power feeds and handwheel and ratchet-lever feeds.

A feature of the back-gear arrangement lies in the type of key spring installed, a spiral spring being used in place of the commonly employed semi-elliptical type. A special construction of the change-speed collar was necessary in order to obtain a movable base for the spring that would act in unison with the forward and backward action of the key lock. The use of a spiral spring is said to insure a uniform and maximum pressure to the key in all positions. The spiral spring consists of fourteen coils of music wire, 0.023 inch thick.

All feeds are obtainable without stopping the mechanism, and a quick adjustment from a plain to a back-geared drive may be had by disengaging a knurled knob in the top gear and throwing in the back-gears by means of a hand-lever. A lock-screw is employed to hold this lever in place. An

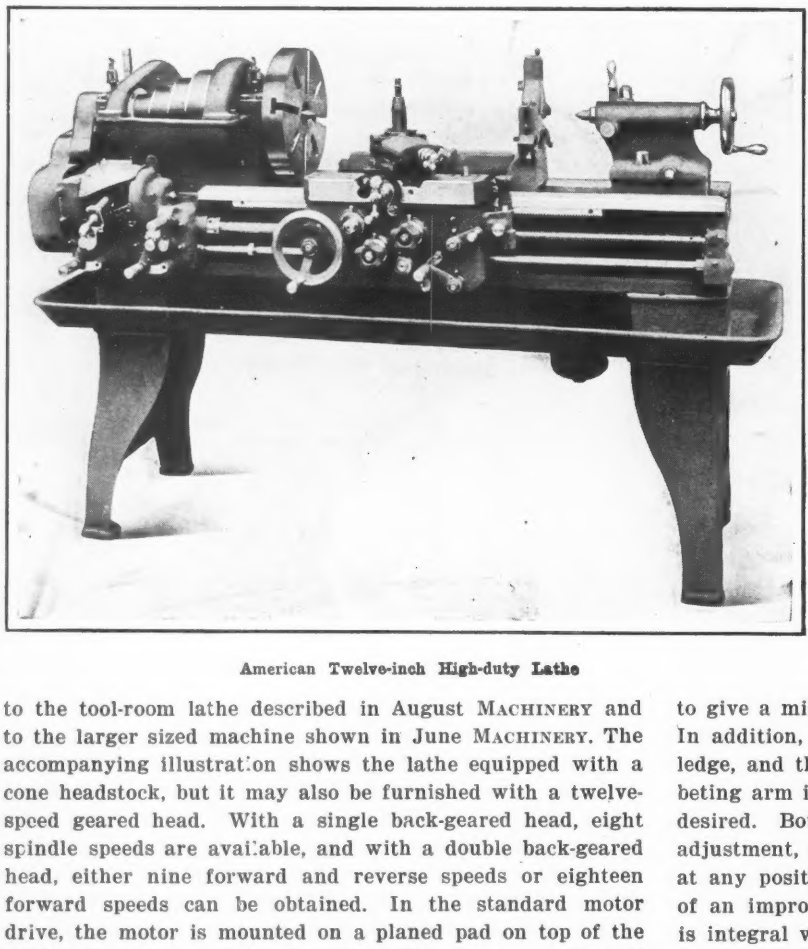


Buffalo Geared Upright Drilling Machine

adjustable automatic trip throws out the power feed when a piece has been drilled to the desired depth. When desired, a tapping attachment of the double-jaw clutch type can be furnished. The machine is rated as having a capacity for drilling holes up to 1½ inches in diameter. Some of the main specifications are as follows: Maximum distance from base to spindle nose, 39 inches; maximum distance from spindle nose to table, 22 inches; spindle travel, 12½ inches; diameter of round table, 16½ inches; floor space required, 16 by 47 inches; and weight, about 970 pounds.

AMERICAN TWELVE-INCH LATHE

A high-duty lathe of 12-inch swing has recently been added to the line of lathes built by the American Tool Works Co., Cincinnati, Ohio. The new size is similar in design

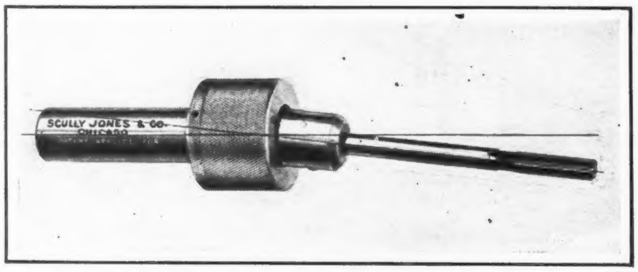


American Twelve-inch High-duty Lathe

to the tool-room lathe described in August MACHINERY and to the larger sized machine shown in June MACHINERY. The accompanying illustration shows the lathe equipped with a cone headstock, but it may also be furnished with a twelve-speed geared head. With a single back-geared head, eight spindle speeds are available, and with a double back-geared head, either nine forward and reverse speeds or eighteen forward speeds can be obtained. In the standard motor drive, the motor is mounted on a planed pad on top of the headstock and is connected to the initial shaft in the head through a train of three helical gears, but other types of motor drive may also be furnished.

SCULLY-JONES SELF-ALIGNING REAMER HOLDER

A self-aligning reamer-holder made by Scully-Jones & Co., 13th and Robey Sts., Chicago, Ill., which allows reamers to conform to any angular irregularities in the alignment of the machine spindle and the work, is shown in the accompanying illustration. This device also holds the tool parallel with the axis of the rotating part. It is recommended that a pilot guide be used with the holder on all tools. Friction is practically eliminated in this holder by the use of ball thrust bearings between the hardened and ground surfaces. The couplings employed insure a positive drive for the collets without interfering with the smooth floating action. A knurled knob retains the assembled parts as a unit, and serves as an adjusting nut to regulate the clear-



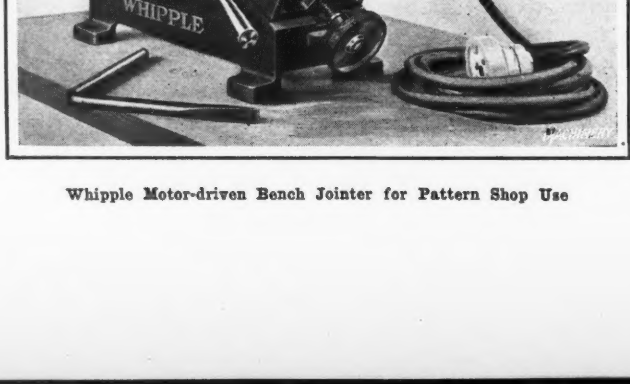
Scully-Jones Self-aligning Reamer-holder

ance that controls the floating action of the holder. The shank is made tapered or straight to fit any size or style of machine socket, and the collets may have a male or female taper or be straight with plain holes or with broached holes for tools with square shanks. The holder is made in five sizes for reamers from ½ to 3 inches in diameter.

WHIPPLE MOTOR-DRIVEN BENCH JOINTER

The Whipple model No. 1 motor-driven 4-inch bench jointer built by the Nazel Engineering & Machine Works, 4043 N. 5th St., Philadelphia, Pa., is equipped with instantly detachable tables, gage, and guard. These members may be removed without disturbing the position of the set-up, so as to give the operator access to one-half the circumference of the cutter-head for sharpening and adjusting the cutters. The parts mentioned can be detached and replaced within a minute. Another feature is a cylinder and motor equipped with ball bearings made especially to meet the demands of high speeds and heavy-duty service.

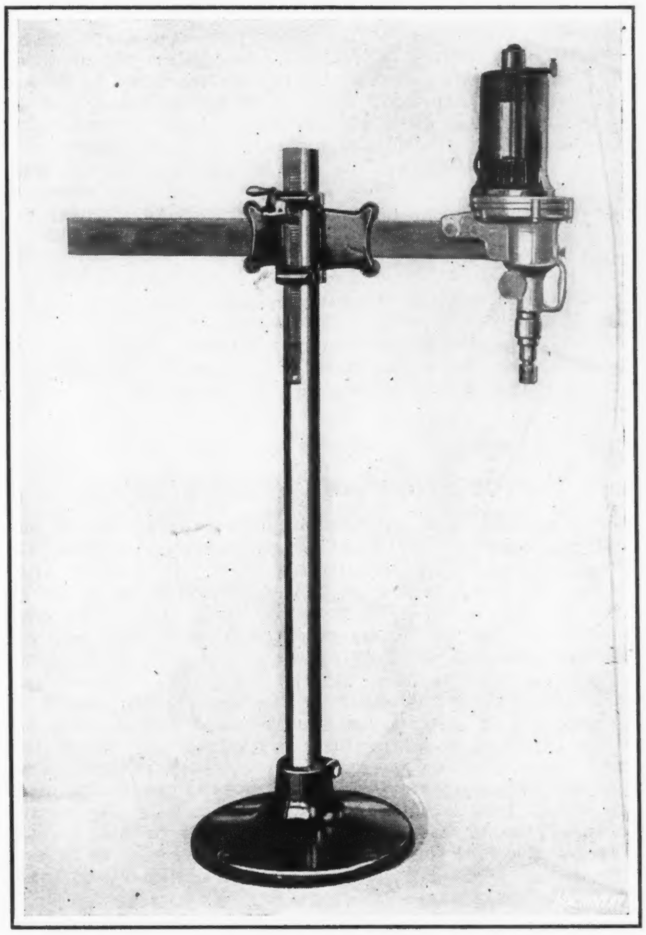
The inclined ways of the frame and tables are of the tongue-and-groove type, and are machined and scraped, the working surfaces of the table being ground and fitted to insure correct alignment. The tables are provided with inserted steel lips which are machined to give a minimum opening at the cutting circle of ⅞ inch. In addition, the rear table has a ⅜- by 1½-inch rabbeting ledge, and the front table is extended to suit. Thus a rabbeting arm is not necessary, but one can be furnished when desired. Both tables have the customary range of vertical adjustment, and are rigidly clamped to their inclined seats at any position by means of cam clamps. The cylinder is of an improved, three-knife, solid circular safety type, and is integral with the rotor shaft of the motor. The gage or fence is adjustable across the full width of the machine, and can be set at any angle up to 45 degrees. The height to top of table is 7 inches; length, 20½ inches; width, 13½ inches; and length of front table, 10½ inches.



Whipple Motor-driven Bench Jointer for Pattern Shop Use

ELECDRIVE STATIONARY EQUIPMENT

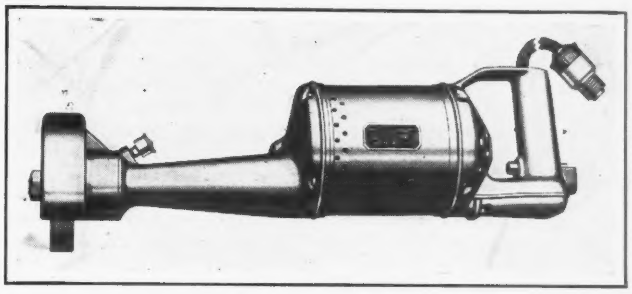
A self-contained stationary equipment is built by the Elecdrive Mfg. Co., Inc., Drawer 34, Syracuse, N. Y., for rapidly tightening nuts, driving screws and studs, and drilling or reaming holes, when assembling work. It will be seen from the illustration that the unit consists essentially of a column carriage, arm, and an Elecdrive tool designed along the same lines as the portable tool made by this company. The stationary machine is recommended for use on work that can be brought to it, or on work in which the center line of the part to be driven is in a vertical plane; whereas the portable tool is preferable where the nature of the work prevents its being carried to a machine or where the center line of the part to be driven is not in a vertical plane. The portable tools are also more desirable where the number of parts to be driven is limited, so that the expenditure necessary for a machine is unwarranted.



Elecdrive Equipment for driving Nuts, Screws, and Studs, and for Drilling and Reaming Operations

The base of the stationary machine has four finished surfaces that rest on the floor, with holes for bolting it in place. It is split part way to permit turning the column in it when a clamping nut has been loosened. The column is a piece of seamless tubing, ground and polished, and provided with a rack which is engaged by a pinion on the carriage. Raising and lowering of the carriage are accomplished by turning a crank. The carriage is mounted on two hardened and ground pins in such a manner that the tool can be swung through an arc of approximately 180 degrees without turning the column in the base.

Both the portable tool and the stationary machine are built under a basic patent covering the operation of a friction clutch which is used in combination with a positive clutch. This feature permits the ready engagement of the driving tool with the part to be driven, and after the part is seated the driving tool is disengaged while the motor is running at full speed. Large numbers of nuts, screws or studs may be driven to a uniform degree of tightness by means of this construction. The portable tool is made in three sizes, and the stationary machine in two sizes.



Universal-motor Hand Grinder and Buffer made by the Cincinnati Electrical Tool Co.

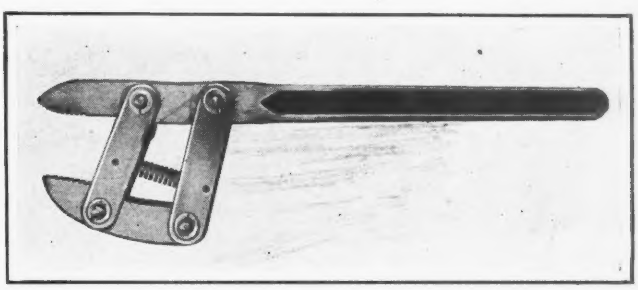
CINCINNATI HAND GRINDER AND BUFFER

A portable electric hand grinder and buffer provided with a 12-inch extension for the wheel has recently been put on the market by the Cincinnati Electrical Tool Co., 1507 Freeman Ave., Cincinnati, Ohio. This grinder is made in two sizes, 1/4 and 1/2 horsepower, with speeds of 5500 and 3600 revolutions per minute, respectively. The smaller size weighs 14 pounds, and the larger 23 pounds. The motor is of the universal type, so that the tool can be used on either alternating or direct current of the same voltage. The motor is semi-enclosed, is dirt- and dust-proof and may receive power from any lamp socket. The armature spindle is mounted on ball bearings, and the motor is air-cooled by a fan on the armature shaft.

The switch is located in the "pistol-grip" handle, so that the grinder is under the immediate control of the operator. Grease cups are provided for spindle lubrication. This grinder is particularly adapted for cleaning castings in the machine shop, grinding off the flash of welds, and body building. It is also handy for polishing and buffing.

ROBERT SELF-ADJUSTING WRENCH

A self-adjusting wrench, which may be used to turn any shaped part from small nuts up to 1 1/4-inch pipe, is manufactured by the Robert Wrench Co., Poughkeepsie, N. Y. This is known as the Robert wrench, and is made up of high-carbon steel drop-forgings. As will be seen from the illustration, a movable jaw is attached to the jaw end of a handle by means of two links of different lengths. The difference in the length of the links, combined with the action of a spring, ordinarily tends to push the movable jaw toward the jaw end of the handle. This tendency is overcome when pushing the jaws against an object to engage it, but when the wrench is applied to turn the object, the harder it is pulled, the stronger it grips. This wrench is sold by the Greater Service Co., 53 Halsey St., Newark, N. J.



Robert Self-adjusting Wrench

NEW MACHINERY AND TOOLS NOTES

Semi-automatic Bench Milling Machine: Weed Engineering Works, 740 Union Ave., Bridgeport, Conn. A semi-automatic bench milling machine designed for the rapid and accurate production of small interchangeable parts for firearms, sewing machines, typewriters, etc. The working feed is driven by worm-gearing, and the reverse feed by bevel gears. There are four available feed changes from 1.145 to 5.26 inches per minute. The automatic quick-return is at the rate of 92 inches per minute. Six spindle speeds from 80 to 268 revolutions per minute are obtainable. The work is placed in a vise or fixture and the feed-lever tripped by hand, after which the table is fed until the completion of the cut, when an adjustable stop reverses the feed mechanism to return the table to the starting position at the high speed. One operator can handle several machines. The maximum distance from the top of the table to the center of the spindle is 5½ inches, and the minimum distance, 1¾ inches. The weight of this machine is approximately 450 pounds.

* * *

TRADE NOTES

New Britain Machine Co., New Britain, Conn., has moved its Detroit office from the Garfield Bldg. to 2-130 General Motors Bldg.

Standard Turbine Corporation, Wellsville, N. Y., has appointed the Percy E. Wright Engineering Co., as its Seattle agent. The office of the company is at 2012 L. C. Smith Bldg., Seattle, Wash.

Standard Shop Equipment Co., manufacturer of Cad setup apparatus, has recently moved from its former location at 23rd and Hunting Park Ave., Philadelphia, Pa., to 82nd and Tinicun Ave., Philadelphia.

Linde Air Products Co. has established a new warehouse at the B. & M. Wharf, Portland, Me., in order to give improved service to users of Linde oxygen and Prest-O-Lite acetylene in the state of Maine. S. W. Jordan, 11 Exchange St., Portland, will be in charge of distribution.

United States Electrical Tool Co., Cincinnati, Ohio, has opened an office in Toledo at 110-112 Eleventh St., with J. E. Hauser as district manager. In this, as in all other district offices of the company, a large stock of tools will be carried and a well equipped service station maintained.

D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill., manufacturer of cut gears and speed-reducing devices is erecting an addition to its plant, 50 by 125 feet, consisting of three stories and a basement. The company reports an active business, and expects to make another addition to its plant in the near future.

Irvington Machine Co., 297 Badger Ave., Newark, N. J., has recently purchased the assets and manufacturing rights of the Liberty Tool Co., of Irvington, N. J., and is manufacturing a line of grinding machines. The company is specializing on a cylinder grinding attachment for an engine lathe, marketed under the name of "Trubloc."

Standard Steel & Bearings, Inc., formerly located at Philadelphia, Pa., announces that the Philadelphia plant has been completely removed to its new location at Plainville, Conn. The company now has a spacious one-floor plant, permitting the most efficient arrangement of tools and equipment instead of a multi-storied factory in a congested metropolitan district.

Philadelphia Gear Works, 1120-1128 Vine St., Philadelphia, Pa., is building an addition of 15,000 square feet to its plant No. 2 located at Tioga and Salmon Sts., which will increase the capacity of that plant over 50 per cent. The increasing volume of business has made it necessary to add considerable new machinery, which in turn, has made increased floor space imperative. The company has recently opened an office at 50 Church St., New York City, in order more completely to serve the trade in that territory. John K. Rewalt, formerly sales engineer at the Philadelphia office, is in charge of the New York office.

Crane-Schiefer-Owens, Inc., has succeeded the Crane Machinery Co., and on September 4 established offices in Buffalo, Rochester, and Syracuse. Robert L. Crane, general manager of the Crane Machinery Co., and formerly western New York manager of Henry Prentiss & Co. for twenty-three years, will have charge of the home office in Buffalo, at 501 Morgan Bldg. Frederick W. Schiefer, manager of Henry Prentiss & Co. of Rochester for the last nine years, will have charge of the Rochester office, and Joseph F. Owens, sales manager for the last eleven years of the Lapointe Machine Tool Co., Hudson, Mass., will be in charge of the Syracuse office.

MACHINE TOOL EXHIBITION IN NEW HAVEN

The third annual machine tool exhibition at Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn., was held September 18 to 21, under the joint auspices of the New Haven Section of the American Society of Mechanical Engineers, Yale University, and the New Haven Chamber of Commerce. The exhibition, which was distributed over three floors, was an exceptionally interesting one in that a great number of exhibitors had their machines in operation, demonstrating new and improved features. There were in all about 120 different exhibitors, not only from New England but from many other sections of the United States, particularly from Ohio. The visitors included engineers and works executives from many of the leading shops throughout New England.

In addition to the exhibition, evening meetings were held. At the meeting on Wednesday evening, September 19, Professor Joseph W. Roe of New York University, president of the Society of Industrial Engineers, spoke on "The Origin of Machine Tool Building," and Guy Hubbard, engineer of the National Acme Co., Windsor, Vt., spoke on "An Industrial Birthplace of Pioneer Machine Builders," in which he referred to the early industrial developments in Windsor. Thursday evening, September 20, an operating demonstration of a number of machine tools was held in the auditorium. The machines demonstrated included a hammer built by the High Speed Hammer Co., Inc., Rochester, N. Y.; the combination machine developed by the Triplex Machine Tool Co., New York City, and built by B. C. Ames Co., Waltham, Mass., and the new subheadstock recently brought out by the Hendey Machine Co., Torrington, Conn., by means of which it is possible to obtain unusually slow speeds. A description illustrated by lantern slides was presented of the "Contin-U-Matic" chucking and turning machine designed and built by the Bullard Machine Tool Co., Bridgeport, Conn.

It was reported that a number of sales were made on the exhibition floor, and most of the exhibitors expressed satisfaction with the results of the exhibition.

* * *

AUTOMATIC PRODUCTION MEETING

Machine tools and production methods that are of particular interest to manufacturing executives will be discussed at the Production Meeting of the Society of Automotive Engineers to be held in Cleveland, October 25 to 27. This meeting is intended to serve as a national clearing house where factory managers may exchange ideas and discuss production problems to their common benefit and for the general good of the industry. Over five hundred production men took advantage of the opportunity offered by the meeting in Detroit last October and voiced their approval of it as a means of perpetuating the cooperative spirit among factory experts. Exchange of practical shop information is now fairly universal, and the production meeting merely fosters this exchange to a greater degree and on an organized basis. The meeting will be held in the Rainbow Room of the Winton Hotel. There will be several professional sessions, a production man's dinner and interesting factory visits.

A. J. Ott and C. L. Ott of the American Grinder Co., Detroit, Mich., will describe a gear-grinding process developed by their company. A. F. Shore, president of the Shore Instrument & Mfg. Co., Jamaica, N. Y., will present a comprehensive paper on the proper use of the scleroscope. A paper will also be read by E. P. Blanchard of the Bullard Machine Tool Co., Bridgeport, Conn.

H. P. Harrison of the H. H. Franklin Mfg. Co., Syracuse, N. Y., will present the experiences of that organization in the installation of conveyor equipment, showing lay-outs that have proved most efficient and describing others that have not been satisfactory. Ralph E. Flanders of the Jones & Lamson Machine Co., Springfield, Vt., will read a paper on special-purpose machinery versus general-purpose machines. W. F. Jameson, chief inspector of the Cleveland Motor Car Co., Cleveland, Ohio, is preparing an interesting study on the human element in production. A. H. Frauenthal, chief inspector of the Chandler Motor Car Co., Cleveland, Ohio, will describe some interesting work he has been doing in measuring "out-of-roundness." Oscar A. Knight of the Norton Co., Worcester, Mass., will describe some of the latest applications of grinding in automotive production. Percy S. Brown, works manager of the Corona Typewriter Co., will bring in the experiences of another industry in the application of the Taylor Society's principles of scientific management. Tickets for the dinner and copies of the complete and final program may be secured by addressing the Society of Automotive Engineers, 29 W. 39th St., New York City.

OBITUARIES

JOHN E. SNYDER

John E. Snyder, founder and head of J. E. Snyder & Son of Worcester, Mass., manufacturers of upright drills, died of heart disease under tragic conditions on August 25, near his summer camp in Nova Scotia. Fishing from a canoe with Mrs. Snyder and a guide, while he was casting, Mr. Snyder rose suddenly clasping his heart convulsively, and his body plunged headlong into the lake, capsizing the canoe and throwing Mrs. Snyder and the guide into the water. She sank twice but was rescued by the guide.

Mr. Snyder was born in Lubec, Maine, in 1850, received a public school education, and at the age of twelve shipped on a fishing schooner; at fourteen entered the U. S. Revenue service, where he continued until 1865; then became an apprentice in the shop of P. Blaisdell & Co. of Worcester, makers of machine tools.

In 1882, with a capital of only $600, Mr. Snyder started in business for himself making upright drilling machines, and after several removals to larger shops, necessitated by increasing business, in 1917 built his present shop on Dewey St., Worcester. In 1904 his son, Milton C. Snyder, was admitted to partnership and the firm became J. E. Snyder & Son.

Mr. Snyder was one of the thorough, careful type of New England machine tool builders, who took great pride in his product and preferred to have a comparatively small shop over which he could exercise careful, personal supervision. His upright drilling machines rank among the highest, and are to be found wherever machine tools are used, the world over.

Mr. Snyder left a widow, one son, who will continue the business, and two married daughters.

Waldo H. Marshall, chairman of the board of directors and president of the Consolidated Machine Tool Corporation of America, died August 23, at his summer home at Barnstable, Mass., after an illness of about one week, aged fifty-nine years. Mr. Marshall devoted the earlier years of his business life to railroad operating work. From 1897 to 1899 he was assistant superintendent of motive power for the Chicago and North Western Railroad, and later became superintendent of motive power, general superintendent, and general manager of the Lake Shore & Michigan Southern Railroad. He left this position in 1906 to become president of the American Locomotive Co., an office which he held until 1917, when he became associated with J. P. Morgan & Co. In 1918 he was appointed chief of the Production Division of the Ordnance Department of the United States Army. He became president of the Consolidated Machine Tool Corporation in March, 1923.

George Maclagan, president and treasurer of the Garvin Machine Company, of New York, died suddenly of apoplexy at his home in Mountain Lakes, N. J., on September 15. He was born in Canada, October 2, 1858, and was connected with McKesson & Robbins, wholesale druggists, before he became associated with the Garvin Machine Co. in 1901.

Mr. Maclagan was a man of high ideals, of which he made a practical application in his business. He was for many years a warden at St. John's Episcopal Church, Passaic, N. J., and retained that office after his removal to Mountain Lakes. He left three daughters, with one of whom he made his home in Mountain Lakes.

As Machinery goes to press a cable from Paris tells of the death of Francis Fenwick, for many years head of Fenwick Freres & Co., of Paris, the well-known machinery merchants. Mr. Fenwick had been in declining health for some time, and the immediate cause of his death was heart failure. American machine tool manufacturers will learn with deep regret of the death of Mr. Fenwick. His company, which has a fine reputation in America as well as in France, was the first to import and deal in American machine tools in France and has always represented American machine tools exclusively. In recent years Mr. Jacques Fenwick, a nephew of Mr. Fenwick, has taken an active part in the business.

Charles P. Russell, a pioneer in the manufacture of taps and dies, and an early inventor in the tap and die industry, died at his home in Greenfield, Mass., August 27, aged eighty-three years. Mr. Russell was born in Candia, N. H., and passed his early years mostly in Washington, D. C., and New York City. In 1871 he became associated with S. N. Wiley and formed the firm of Wiley & Russell in Greenfield, which developed into a business of important proportions and which was merged some years ago into the Greenfield Tap & Die Corporation. Mr. Russell retired from active business in 1912, at which time he was president of the Wiley & Russell Mfg. Co.

Langdon Gibson, who had been associated with the General Electric Co., Schenectady, N. Y., for thirty-one years, serving as production manager up to two years ago, died September 5, at Criehaven, Me.

PERSONALS

N. B. Norris has been appointed manager of the New Orleans office at 938 Whitney-Central Bldg., of the Pawling & Harnischfeger Co., Milwaukee, Wis., builder of traveling cranes and hoists, and excavating machinery.

John P. O'Connor has been appointed manager of the Seattle office of E. C. Atkins & Co., Inc., Indianapolis, Ind., manufacturers of saws, saw tools, and saw specialties. This branch office is located at 510 First St., Seattle, Wash.

M. D. Hopkins has been appointed western representative, with headquarters at Chicago, of the Max Ams Machine Co., 101 Park Ave., New York City, manufacturer of automatic machinery for cans and metal containers.

J. D. Phillips has been appointed office manager of the new Oakland, Cal., plant of the General Electric Co., Schenectady, N. Y. Mr. Phillips, who was formerly traveling auditor, will have charge of accounting, statistics, payrolls and all clerical operations at these works.

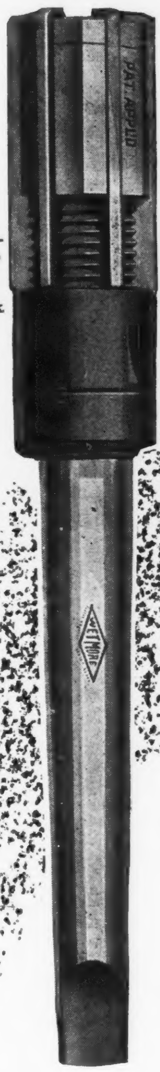
Walter A. Deems, for the last ten years master mechanic of the Baltimore & Ohio Railway's New York terminals and the Staten Island Rapid Transit Co., has joined the machine tool department's sales organization of Manning, Maxwell & Moore, Inc., with headquarters at 100 E. 42nd St., New York City.

E. D. Spicer, formerly works manager of the Kerr Turbine Co., has become general manager of the Standard Turbine Corporation, of Wellsville, N. Y. H. R. Geiger, has been appointed New York manager of the standard Turbine Corporation. Mr. Geiger previously served as engineer and sales representative in metropolitan engineering and trade circles. His office is at 350 Madison Ave., New York City.

Henry J. Bailey was elected president of the Consolidated Machine Tool Corporation of America, Rochester, N. Y., at a recent meeting of the board of directors to succeed Waldo H. Marshall, who died on August 23, after a brief illness. From the time that this company was formed Mr. Bailey had been vice-president in charge of the Hilles & Jones Works, Wilmington, Del. He had been connected with the Hilles & Jones Co., prior to the consolidation, for over thirty-two years, working his way through the different departments and becoming successively sales manager, general manager, and president. He occupied the position of president when the company was merged into the Consolidated Machine Tool Corporation of America.

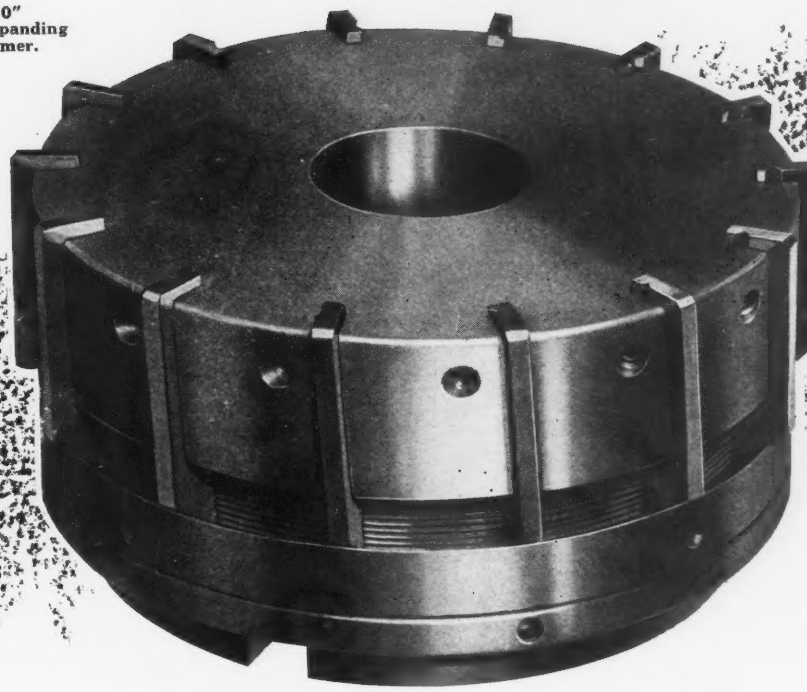
James W. Hook, for the past six years president of the Allied Machinery Co. of America, has resigned that position to become associated with the Geometric Tool Co., New Haven, Conn., as vice-president and general manager. Mr. Hook is a graduate of Ames University of Ames, Iowa, class of 1905, and began his business connection with the machinery industry in 1906 with the Globe Machinery & Supply Co. of Des Moines, Iowa. Later he was connected with C. A. Dunham Co. at Marshalltown, Iowa, manufacturers of steam specialties, first as sales manager and later as general manager. In his new connection he will have an extended opportunity to apply his energy and initiative, and to utilize his wide acquaintance and experience in the machinery industry where he is highly regarded.

5/8" to 10"



Wetmore Expanding Small Machine Reamers—5/8" to 31/32", straight or taper shank

Special 10" Wetmore Expanding Shell Reamer.



—and any size in between!

No matter how small or how large a reamer you need, get a *Wetmore Expanding Reamer.* This famous reamer—now standard equipment in many of America's largest plants—ranges in size by thirty-seconds from 5/8" to 10" diameter. If the size you want isn't in stock, we will make it for you.

Here are four reasons why Wetmore Reamers cut production costs—do faster, more accurate work and stand up longer in service.

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone expansion nut keeps blades always parallel with axis.

Solid, heat-treated alloy steel body guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.

FREE CATALOG

Write for your copy of the Wetmore catalog of standard, heavy-duty, shell, small machine and cylinder reamers. Also arbors and replacement blades. Sent FREE, POSTPAID; no obligation to you.

Let us prove these Wetmore advantages in *your* shop.

WETMORE REAMER COMPANY

MILWAUKEE, WISCONSIN

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

COMING EVENTS

October 1-5—Twelfth annual congress of the National Safety Council at Buffalo, N. Y.; headquarters, Hotel Statler.

October 8-12—Annual convention of the American Society for Steel Treating to be held in Pittsburg, Pa., in connection with an international steel exposition. W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio, national secretary.

October 25-26—Production meeting of the Society of Automotive Engineers at Cleveland, Ohio. Further information may be obtained from the society's headquarters, 29 W. 39th St., New York.

October 25-27—Fall meeting of the American Gear Manufacturers' Association at the Mountain House, Lake Mohonk, N. Y. Secretary, T. W. Owen, Room 107, 2443 Prospect Ave., Cleveland, Ohio.

October 29-31—Convention of the American Management Association in New York City; headquarters, Hotel Astor. Further information can be obtained from the secretary of the association at 20 Vesey St., New York City.

December 3-6—Annual meeting of the American Society of Mechanical Engineers in New York City. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

December 3-8—Second annual exposition of power and mechanical engineering in the Grand Central Palace, New York City.

January 22-25—Annual meeting of the Society of Automotive Engineers in the General Motors Building, Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

June 4-6, 1924—Eleventh annual foreign trade convention in Boston, Mass. O. K. Davis, India House, Hanover Square, New York City, secretary.

NEW BOOKS AND PAMPHLETS

Invar and Related Nickel Steels. 93 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 58 of the Bureau of Standards. Price, 30 cents.

Where and How to Find the Law. By Frank Hall Childs. 119 pages, 5¼ by 8½ inches. Published by the La Salle Extension University, Michigan Ave. and 41st St., Chicago, Ill. Price, $1.50, postpaid.

This book should be of value to business men as a guide in finding the law. It is pointed out in the introduction that even lawyers cannot be familiar with all the laws, but must know where to go to find the laws applicable to all kinds of cases. Such knowledge would often be of value to business men as well, and this book should therefore serve a useful purpose in this field. The book contains an insert on which a chart is shown which classifies American legal publications. The material is divided into two sections, the first dealing with where to find the law, and the second, with how to find the law. It is indexed so that it can easily be referred to.

Details of Typical Mechanisms. By C. M. Linley. 101 pages, 4½ by 7½ inches; 85 illustrations. Published by Scott, Greenwood & Son, London, England, and distributed in America by the D. Van Nostrand Co., 8 Warren St., New York City. List price, $2, postpaid.

The object of this work, as stated by the author in the foreword, is to make clear certain features in connection with the design and application of those mechanisms that are commonly employed in almost all classes of machinery. It is not intended to cover the whole subject of mechanical movements and mechanisms. In dealing with the various mechanisms described, the purpose is to point out the more subtle features rather than to describe them as a whole. The mechanisms dealt with are as follows: Ratchets; clutches; gears; joints; screws; brakes; reversing mechanisms; belt and chain drives; worm-gears; stops and releasing mechanisms; and ball bearings.

Mechanics of Machinery. By Robert C. H. Heck. 508 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $5.

The purpose of this work is to cover the whole field of motions and forces in machines, the aim being to put this division of engineering knowledge into more effective shape for study and teaching. As the subject is too large to be confined to a single volume, it has been divided into two parts. The present book covers the first part of the work and deals principally with mechanism. The second volume will deal with kinematics and dynamics of machines. The material has been arranged according to the kind of problems presented in mechanism rather than according to the different kinds of machines. The three main divisions are: Machinery for uniform motion; machinery for intermittent motion, and machinery for cyclical or reciprocating motion. Many examples and problems are given. The book contains eight chapters, headed as follows: Elements and Principles of Machines; Machinery for Uniform Motion; Intermittent Motion; Gear Trains for Speed Variation; Cyclic and Differential Trains; Linkage Mechanisms and Movements; Form, Action, and Production of Gear Teeth; and Gear Teeth in Space.

NEW CATALOGUES AND CIRCULARS

Norton Co., Worcester, Mass. Circular illustrating the use of alundum safety treads for stairways.

Michigan College of Mines, Houghton, Mich. Year book of the college for 1922-1923, containing calendar, outline of courses, etc.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Circular illustrating some of the many applications of the Shepard "Liftabout" electric hoist.

Consolidated Tool Works, Inc., 296 Broadway, New York City. Circular illustrating and describing ratchet bit braces in three different types, with 8-inch, 10-inch, and 12-inch sweep.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1046, illustrating and describing type ZK, manual-automatic compensators for alternating-current squirrel-cage motors.

Buffalo Forge Co., Buffalo, N. Y. Circulars illustrating and describing Buffalo 10-inch power bench drill, 10-inch motor-driven Junior drill, No. 210 rivet forge, and the "Bufco" forge.

William Asquith (1920) Ltd., Highroad Well Works, Halifax, England. Catalogue of Asquith portable universal drilling and tapping machines, showing examples of their use for various classes of work.

Surplus Steel & Iron Service, 327 S. LaSalle St., Chicago, Ill. Pamphlets containing lists of the products handled by this concern, which include iron and steel, machinery and equipment, and factory supplies.

Irvington Machine Co., 297 Badger Ave., Newark, N. J. Circular illustrating and describing the "Trubloc" cylinder grinding attachment for engine lathes, which has been designed to meet the requirements of repair, machine, and welding shops.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Miniature catalogue 3027, briefly describing the complete line of Hisey products, including 112 different sizes and types of portable electric tools. Copies will be sent to those interested, upon request.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Publication 3062, illustrating and describing the electric conduction heaters made by this company. General industrial and machine applications of the heaters are illustrated, and the different forms are described.

Glow-Brite Co., 1006 Rockefeller Bldg., Cleveland, Ohio. Circular containing information relative to a liquid factory glass cleaner known as "Glow-Brite." This material removes accumulations of dirt, grime, carbon, or rust scale without injury to paint, putty, or sash.

Crescent Truck Co., Lebanon, Pa. Catalogue of the electric industrial trucks and tractors made by this concern, illustrating the various types and showing typical installations for a wide variety of work. Specifications and line drawings of the different types and sizes are included.

Motorbloc Corporation, Summerdale, Philadelphia, Pa. Bulletin S-100, descriptive of the Motorbloc chain hoist. The pamphlet contains illustrations showing this motor-driven hoist in actual use under different conditions of service. The details of construction are described, and specifications of the different sizes are included.

Bristol Co., Waterbury, Conn. Bulletin 319, descriptive of Bristol-Fuller controller valves for use in connection with automatic temperature controlling apparatus to control the flow of air and gas, air and oil, steam and oil, and other liquids. Some of the different types of valves suitable for a variety of installations are illustrated.

Electric Power Club, 900 B. F. Keith Bldg., Cleveland, Ohio, has published a pamphlet containing specifications for building equipment control apparatus. It is believed that adherence to these requirements will permit of simplification of controller manufacture, improved service, economies in installation, and other advantages of standardized practice.

J. H. H. Voss, 154 Nassau St., New York City, is issuing the first number of a publication known as the "Voss Valve News," containing articles descriptive of the Voss automatic safety ring gas compressors, and the application of plate valves to air, ammonia, and for all pressures. Copies of this publication will be sent to those interested in these subjects.

Cushman Chuck Co., Hartford, Conn. Catalogue 60, of Cushman chucks containing illustrations and tables of dimensions, weights, prices, etc. Among the styles shown are included a new independent chuck, a universal scroll chuck with two-piece jaws, and an improved box body type of two-jaw chuck. A new feature of these chucks is interchangeability of the parts.

Cincinnati Grinder Co., Cincinnati, Ohio. Catalogue covering the Cincinnati line of universal grinding machines for external grinding of straight or tapered cylindrical work, internal grinding of either straight or tapered pieces, the grinding of flat work, as well as tool-room and manufacturing work. The different sizes of machines are illustrated, and a table of dimensions is included.

Cisco Machine Tool Co., Cincinnati, Ohio. Catalogue containing a brief description and illustrations of the Cisco line of engine or tool-room lathes which are made in 14-, 16-, 18-, 20-, 24-, and 26-inch sizes, as well as rapid-production lathes, made in 16-, and 18-inch sizes. The catalogue also illustrates special lathes made by this concern, and the attachments provided for all sizes of lathes.

Gillis & Geohegan, 55 West Broadway, New York City. New twenty-four page, 8½- by 11-inch, two-color catalogue of G & G telescopic hoists, containing photographs of actual installations of these hoists and two forms of specifications for each model. The catalogue is distributed in a special folder that fits a vertical filing cabinet. Anyone interested may obtain a copy by writing to this company.

Schatz Mfg. Co., Poughkeepsie, N. Y. Catalogue 8, covering "Commercial" annular ball bearings and rollers. The sections devoted to bearings contain considerable new material and those devoted to rollers are entirely new, as the rollers constitute a new product of the company's. The catalogue gives complete information covering capacity, dimensions, prices, etc., and includes mounting instructions.

Reliance Electric & Engineering Co., 1056 Ivanhoe Rd., Cleveland, Ohio. Bulletin 1014, illustrating and describing Reliance type AS adjustable-speed motors of the armature shifting design for direct current. The description covers principle of operation, mechanical details, and general features of construction. A large number of illustrations are included, showing this type of motor applied to different classes of machines.

Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Catalogue 11, illustrating and describing Mumford foundry molding machines. In addition to the halftone illustrations, the pamphlet also contains line illustrations with the various parts numbered and a corresponding list of the parts, so that the construction of the different types will be easily understood. Circular illustrating and giving specifications for the Milwaukee sprue cutter for steel foundry service.

Lees-Bradner Co., Cleveland, Ohio, is issuing a series of data sheets containing gear data, which will be added to from time to time. The first set of sheets covers the following subjects: Solution of right-angle triangles by simple arithmetic; trigonometric functions; spur gears; gear generation on the Lees-Bradner grinder; helical gears; changing spur gears to helical; changing helical gears to spur; tables of tooth parts; spur and helical conversion table.

Mesta Machine Co., Pittsburg, Pa. Pocket edition catalogue of the Mesta line of products, which includes gas and steam engines, rolling mill machinery, rolls and mill pinions, miscellaneous machinery, forgings, and castings. The first section of the book is made up of illustrations showing interior views in the different departments of the company, and the second half, of illustrations showing installations of Mesta gas blowing engines and other products.

Metal & Thermit Corporation, 120 Broadway, New York City. Pamphlet containing information on the subject of thermit rail welding. The pamphlet gives detailed instructions, accompanied by illustrations and drawings, showing steps in making thermit rail welds. Improved apparatus used in connection with thermit rail welding is described in detail and illustrated. Illustrations are also included showing the results of a ten-years' service test of the thermit rail weld, and also rail bending and drop tests.

W. B. Knight Machinery Co., St. Louis, Mo. Circulars 21 to 24, illustrating and describing four different styles of Knight milling and drilling machines; circulars 25, 26, and 27 illustrating and describing, respectively, high-speed milling attachment, horizontal milling attachment and shaping attachment for use on Knight Nos. 2 and 3 milling and drilling machines; circulars 28 and 29 illustrating Knight index-centers, and worm-driven circular milling attachment for use on the Nos. 2 and 3 machines.

McCrosky Tool Corporation, Meadville, Pa. Catalogue 9, of McCrosky tools, describing the details of design of McCrosky "Super" adjustable reamers and the improved features of construction. Following the general description, the various types and sizes of reamers are illustrated, and tables of dimensions and prices are given. The McCrosky floating holders for reamers, taps, etc., are also illustrated and described, as well as improvements in Wizard chucks and collets. Tools not heretofore listed in the catalogue are shown, and two additional styles of McCrosky turrets are included. The other products illustrated in this catalogue are self-centering steadyrests, "Neva-stop" faceplate and dogs, and "Searchlight" lamp brackets.